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Schistosomiasis in Rural Egypt

A Report of U.S.-Egyptian River Nile and Lake Nasser Research Project

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The objectives of this study were to provide current information on the prevalence of schistosomiasis throughout Egypt, to establish trends in the prevalence of schistosomiasis in order to shed light on the potential changes caused by the Aswan High Dam, and to determine correlations between certain environmental variables and the prevalence of the disease. Prevalence was invariably higher in male adolescents with the differential between sexes increasing from north to south. The prevalence was significantly lower in those villagers who obtained water for domestic use from protected supplies. The effect of population growth and migration from rural to urban areas is discussed. Results based on trend analysis of current and past data indicated a strong decline in overall prevalence of the disease in rural populations over the past 40 years The data did not show an increase in the overall prevalence of schistosomiasis following the construction of the Aswan High Dam. The Nubian population also experienced a decrease in prevalence following relocation, with some villages benefiting more than others. Environmental conditions were also correlated against schistosomiasis prevalence and additional aspects of transmission is discussed.

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SCHISTOSOMIASIS IN RURAL EGYPT
A Report of U.S.-Egyptian River Nile and Lake Nasser Research Project

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FOREWORD

After centuries of annual flooding and drought, the constuction of the Aswan High Dam has povided effective flow control to the River Nile as it enters the fertile Egyptian Nile Valley. The dam has resulted in the production of hydroelectric power for municipal, agricultural, and industrial use, and the continuous availability of water has increased agricultural productivity. Optimum benefits from a project of this magnitude cannot be fully realized, however, until the major environmental, agricultural, social, economic, and public health impacts have been incorporated into strategies for managing the water resources within the basin. In 1975, the U.S. Environmental Protection Agency and the Ford Foundation began support of a 5-year, multifaceted research program conducted by the Egyptian Academy of Scientific Research and Technology and related institutions and the University of Michigan to provide the information needed for comprehensive water quality management in the Nile Valley.

Although the project addresses issues of vital importance to Egypt, the knowledge gained also will be of significant benefit to the general scientific community. For example, water resources management models developed for the Nile Basin can be applied to some river basins in the United States.

This report, the first of a series growing out of the public health portion of the U.S.-Egyptian project, describes a research study of the prevalence of schistosomisasis--a chronic disease of the liver, bladder, and lungs--following the regulation of water flow in the river, canals, and drainage ditches brought about by the dam.

David W. Duttweiler
Director
Environmental Research
Laboratory
Athens, Georgia

PREFACE

The Aswan High Dam was built for the purpose of water storage, river flow control and hydroelectric power production. The fulfillment of these goals is of vital importance for Egypt's agricultural and industrial development programs. This can be easily realized since the River Nile constitutes 90% of Egypt's fresh water resources and the present population of 38 million people inhabit approximately four percent of the land and the rest is barren desert. Nevertheless, since its inception, the Aswan High Dam has been under unprecedent attacks in the news media and the scientific literature. It has been blamed for causing serious ecological perturbation which resulted in reducing the fish population in the Mediterranean, lowering the fertility of the Nile Valley, and markedly increasing schistosomiasis in Egypt. In contrast to the above claims, our study indicated a marked decline in schistosomiasis prevalence in rural Egypt over the past forty years.

These research findings are the outcome of a comprehensive ongoing project dedicated to the study of the River Nile and the impacts of the Aswan High Dam on multipurpose river uses. This includes irrigation, community water supply, fishery, recreation, transportation, etc. The aim of this project is to provide the decision makers in Egypt with river management alternatives compatible with government goals for economic development. This includes the assessment of trade-offs and predictions of the outcome of each river resources management alternative. This is a joint project between the Egyptian Academy of Scientific Research and Technology and the University of Michigan. The technical and financial support of the U.S. Environmental Protection Agency, the Ford Foundation, and the World Bank is highly appreciated.

Khalil H. Mancy
Principal Investigator
July 17, 1978

ABSTRACT

The prevalence of schistosomiasis in Egypt has been high for a long time as a result of widespread irrigation schemes. The possible effect of the proposed Aswan High Dam and the resulting formation of Lake Nasser on the prevalence of schistosomiasis created a controversy in both the public and scientific press. It was speculated that the Aswan High Dam and related irrigation development would contribute to an increase in schistosomiasis.

The objectives of this study were to provide current information on the prevalence of schistosomiasis throughout Egypt, to establish trends in the prevalence of schistosomiasis in order to shed light on the potential changes caused by the Aswan High Dam, and to determine correlations between certain environmental variables and schistosomiasis prevalence.

This research was divided into two studies. The first was a field study in thirty-three villages located in Upper Egypt, Upper-Middle Egypt, and the Nile Delta. In the second investigation, eight villages were selected in the resettled Nubian population in Kom Ombo. The sampling methodology used insured that the probability of selection could be calculated for any given person sampled. To evaluate these findings, extensive historical data on schistosomiasis prevalence in Egypt were compiled and assessed for factors of comparability.

The overall prevalence of schistosomiasis, corrected for differences in sampling fraction and age, in seven villages in the north central Nile Delta was 42.1%, in six villages in Upper-Middle Egypt (in the governorate of Beni Suef) the overall prevalence was 26.7%, and in the sixteen villages in the governorate of Aswan, the prevalence was 4.1%. Prevalence was invariably higher in the male adolescents with the differential between sexes increasing from north to south. The prevalence was significantly lower in those villagers who obtained water for domestic use from protected supplies. Villages in Upper Egypt located on dry barren ground had a much lower prevalence, by five times, than the villages surrounded by cultivated lands. The effect of population growth and migration from rural to urban areas on schistosomiasis prevalence and distribution was discussed.

Results based on trend analysis of current and past data indicated a strong decline in overall prevalence of schistosomaisis in the rural population over the past forty years. The data did not show an increase in the overall prevalence of schistosomiasis following the construction of the Aswan High Dam. The Nubian population also experienced a decrease in prevalence following relocation, from 15.2% to 7.2%, with some villages benefiting more than others.

Environmental conditions were also correlated against schistosomiasis prevalence and additional aspects of transmission were discussed. It is hoped that the information presented here on the natural history of schistosomiasis transmission in Egypt will aid in the control and eradication of this disease.

This research was implemented through the River Nile-Lake Nasser project, a joint University of Michigan-Egyptian Academy of Scientific Research and Technology project, and funded by the U.S. Environmental Protection Agency and the World Bank.

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This is a very important section. The size and scope of the activity necessary to compile data on over 15,000 persons living in 41 rural Egyptian villages located at the extremes of the Nile Valley in Egypt is understated in the main body of this thesis. An undertaking of this magnitude, which took me to Egypt for almost three years, obviously required the participation of many others. So many, in fact, that as I write this section a stream of faces, persons, friends that I met and who helped me in many, many ways comes to my mind and shape not just a series of repeated encounters, but an incredible story about some very reassuring aspects of human relationships. The format of this section, however, limits my story to essential aspects. This is not to say that the many that are not mentioned here because of spatial limitations have been forgotten, but rather, to whom I will be forever grateful.

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There were, as mentioned, over 15,000 Egyptian villagers to whom I will be forever frustrated in expressing my appreciation. I can only hope that the results of this study will in some way help control and eradicate this parasitic infection that is so prevalent in their population.

Counterpart to all those in Egypt are my committee members here at the University of Michigan. Professor Morton S. Hilbert was instrumental in guiding me into this aspect of environmental health. His continued open-mindedness and support have been of the greatest assistance. Co-chairing my committee with Professor Hilbert was Professor Khalil H. Mancy. Dr. Mancy is a most respected teacher and friend. I am most grateful to Dr. Arnold Monto for his patience in reviewing many drafts and whose intense involvement in the collection and analysis of the field data was particularly insightful. I also wish to thank Dr. Rolf Deininger for his assistance in computer technology, without which a data set of over 3.0 million characters of information would have been overwhelming. I thank Dr. Peter Meier for his enthusiasm and assistance.

I am very fortunate to have a family that has been so unselfish in assisting me through my many trials and tribulations typically associated with such work. Their understanding and confidence provided the necessary strength to achieve what seemed impossible.

This research was part of a joint University of Michigan-Egyptian Academy of Scientific Research and Technology effort called the River Nile-Lake Nasser project, funded by the U.S. Environmental Protection Agency Funds for the analysis of the field data at the University of Michigan were obtained from the World Bank, contract number 21426.

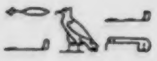
CHAPTER I

INTRODUCTION

The Disease: Schistosomiasis

The evolutionary origins of schistosomiasis most likely stem from the great lakes region of eastern Africa, the hypothesized cradle of man's ancestors (Bruijning, 1971). The host and parasite have over the eons become well adapted to each other and, under natural conditions of the past, severe widespread infections were unusual. The nomadic nature of paleolithic man left little opportunity for endemic foci of infections to develop.

In the papyrus of Kahun (ca. 1900 B.C.) is found the first recorded evidence of haematuria, the classic presentation of Schistosoma haematobium. The hieroglyph ,âaâ,



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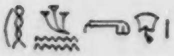

depicted haematuria and its curative magic formula, respectively. There are thirty-nine other remedies recorded on the papyri of Ebers, Berlin, and Hearst (Farooq, 1973).

Calcified ova of S. haematobium were found in Egyptian mummies of the XXth Dynasty (1250-1000 B.C.), directly demonstrating that this parasitic infection did occur in the Nile Valley during the pharonic era (Ruffer, 1910). It also suggests that the highest attainable social status of that period did not exclude one from infection. It is possible that schistosomiasis was widespread and constituted a serious problem during this ancient time. The discovery and classification of the causative trematode (Distoma haematobium) by Theodore Bilharz in 1851 at the Cairo Kasar El Aini hospital and the demonstration that Bulinus snails were the intermediate host to the infection in man in 1915 at El Margh village near Cairo (Leiper, 1915), confirmed Egypt as the "home" of schistosomiasis. Indeed, Egypt still remains the site most frequently studied by scholars interested in this disease, and the Nile Delta is still one of the world's most intense foci of schistosomiasis infection.

Life Cycle of Schistosomiasis

Schistosomiasis is a chronic helminth infection in man caused by the genus of trematodes _Schistosoma_. There are three species: _S. haematobium_, _S. mansoni_, and _S. japonicum_. Two of these species, _S. haematobium_ and _S. mansoni_ are found in Egypt and Africa. _S. japonicum_ is restricted to the orient. The life cycle of all three is very similar. Each ovum (egg) containing a ciliated larva (called miracidium) is passed either in human urine (_S. haematobium_) or in the stool (_S. mansoni_) and hatches on contact with water. The freed miracidium can penetrate the appropriate snail host but must do so within a few hours or die. The genera _Bulinus_, _Biomphalaria_, and _Oncomelania_ are the respective primary snail hosts for _S. haematobium_, _S. mansoni_, and _S. japonicum_. In the snail host, the miracidium becomes a sporocyst which replicates asexually to give rise to the final larval form, the cercaria. The cercariae, after leaving the snail, are capable of penetrating the unbroken skin of the human host, but will not survive for longer than twenty-four hours in water.

Once in the body, the cercariae reach the portal system where they mature into male and female adult worms and mate. The eggs are laid and released to the outside via the bladder or intestine to repeat the life cycle. The cycle of infection from man to snail and back to man can be completed in eleven weeks.

Clinical features of schistosomiasis include fever, hepatospenomegaly, eosinophilia, lymphadenopathy, and malaise. In _S. haematobium_ infections, hematuria is common. Complications of the genito-urinary tract can lead to hydronephrosis. It has been speculated that cancer of the bladder results from the calcification of the bladder walls where eggs have been deposited. The duration of the infection in man has not been firmly established. Viable ova have been recovered from persons who have been free of exposure for over twenty years, (Warren, 1975) indicating that infection, once acquired, can remain for long periods. Re-exposure and reinfection lead to increased worm loads and therefore to more severe clinical consequences. The rate of spontaneous loss of infection was measured by Farooq and Hairston (1966) in Egyptian children. For children aged 5 and 6 the rate of loss of infection was 0.040 cases per year for S. haematobium. S. mansoni had a much higher rate of loss of infection: 0.327 cases per year. Higher loss rates for both species were observed in younger children.

Exact measures of morbidity and mortality have not been made. However, the relationship between worm burden and morbidity is roughly proportional (Cheever, 1968). Severe clinical features are seen in only a small portion of those who are infected (Farooq, et al., 1966b).

The actual role of schistosomiasis as a public health problem is not clear. The contribution to mortality is low. However, the literature pertaining to the contribution by schistosomal infections to morbidity at the community level is conflicting (Jordan, 1972). Reviews by Jordan (1972) and Warren (1975) on this aspect are available. Nevertheless, it has been estimated that over 200 million persons are infected worldwide (Weir, 1969), at an annual cost due to reduced productivity of over $641 million (Wright, 1972).

The Setting: Egypt

Egypt is made up of several distinct sectors. The largest sector is made up of the eastern and western deserts, which account for over 90% of the land mass. The area is populated rather sparsely by nomads, with a few small settlements. Located in the western desert are several more populated oases. El Kharga and El Dakhla oases, in what is referred to as the new valley, are sites of recent agricultural development and currently have a combined population of about 76,000 persons. There are also populated settlements along the western Mediterranean shoreline and along the Suez Canal. Ninety-nine percent of the Egyptian population is compressed in the Nile Valley and in the Nile Delta, 3.5% of the country's land mass. The population density in these areas has been estimated at 2,400 persons per square mile (Waterbury, 1971). For the purposes of this study, the Nile Valley has been divided into:

(a) the delta, or lower Egypt,

(b) Upper-Middle Egypt, between the delta and Assyut, and

(c) southern or Upper Egypt located between Assyut and the Aswan High Dam (AHD), (See Figures 1 and 2). Before the AHD was constructed, there existed a people, called Nubians, located between Aswan and the Sudanese border. When the new lake inundated this area, the Nubians were resettled, en masse, in Kom Ombo, an agricultural plain about 75 km north of Aswan, and in Kheshm El Girba, in the Sudan.

The population of Egypt has always been predominantly "rural," described by Scott (1937) as persons "whose habits of life bring them into contact with fields and canals where infestations with parasites may be acquired." In 1937, 11.49 million persons were living in a rural setting: 72% of the total population of 15.92 million. By 1960, 62% were rural. The rural population has further declined to 56.1%, according to the last census survey conducted in 1976 (CAPMAS, 1976). Accordingly, it is estimated that 21.45 million persons are currently at risk of acquiring the infection, assuming transmission in the urban centers is nil. This is a relatively safe assumption to make since habitats for the snail vectors, i.e. open canals and drains, are not found in the urban areas of Egypt. This does not mean that urban populations in Egypt are free of schistosomiasis infections. New cases of schistosomiasis are constantly being brought into the urban areas due to the steady influx of rural immigrants who have already acquired the disease.

The distribution of the Egyptian population is as follows: 60% of the population resides in Cairo or north of Cairo in the Nile Delta or Lower Egypt, 23% live in Upper-Middle Egypt, and 12% live in Upper Egypt (Omran, 1973). Males comprise 53% of the total population (CAPMAS, 1976).

Dams, Irrigation, and Schistosomiasis

Bruijning (1971) very nicely develops a theme where man, emerging as a cultivator in the fertile basin of the Euphrates and Tigris rivers, tips the balance of infection by schistosomes in favor of the parasite. According to Bruijning, even the earliest attempts at agriculture included irrigation, and irrigation ditches provided new and more favorable habitats for the proliferation of the snail vectors.

The irrigation canals, ditches, or drains, with their smaller water volume and sluggish movement, form a sheltered environment more suitable for snail growth, compared to the irregular and voluminous discharges of the main streams, Dilution of cercarial output is reduced in irrigation ditches, and man and water are brought closer together.

Although Leiper (1915) in Egypt was the first to suggest the role of irrigation in enhancing schistosomiasis transmission, it was Khalil (1927, 1935, 1938), also working

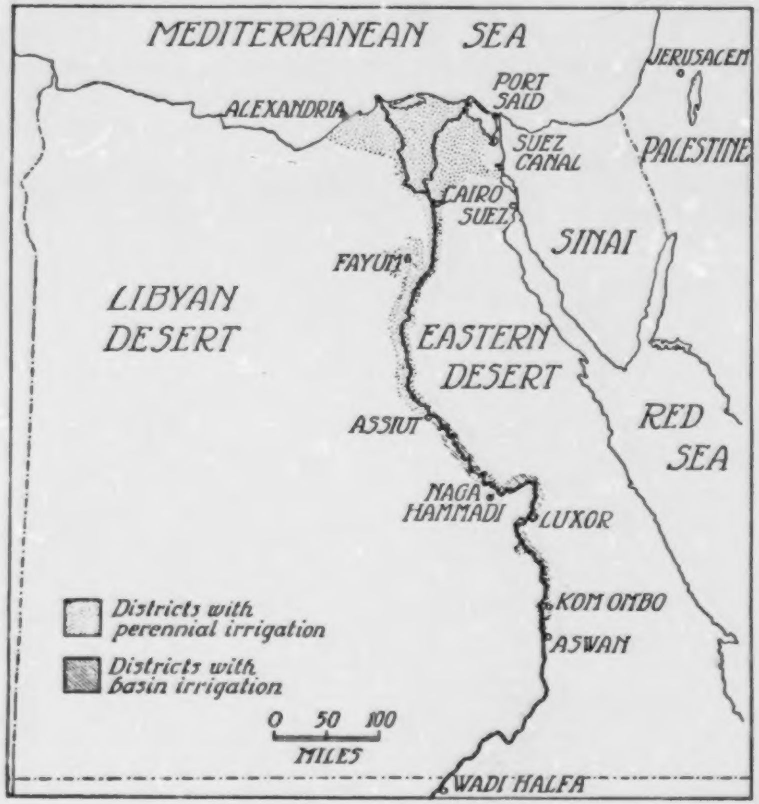

Figure 1. This is a general map of Egypt in the 1930's, after Scott (1937), and shows the extent of perennial irrigation in the country at that time. Now the entire valley is perennially irrigated to Aswan . South of Aswan is Lake Nasser, which extends south of the border into Sudan.

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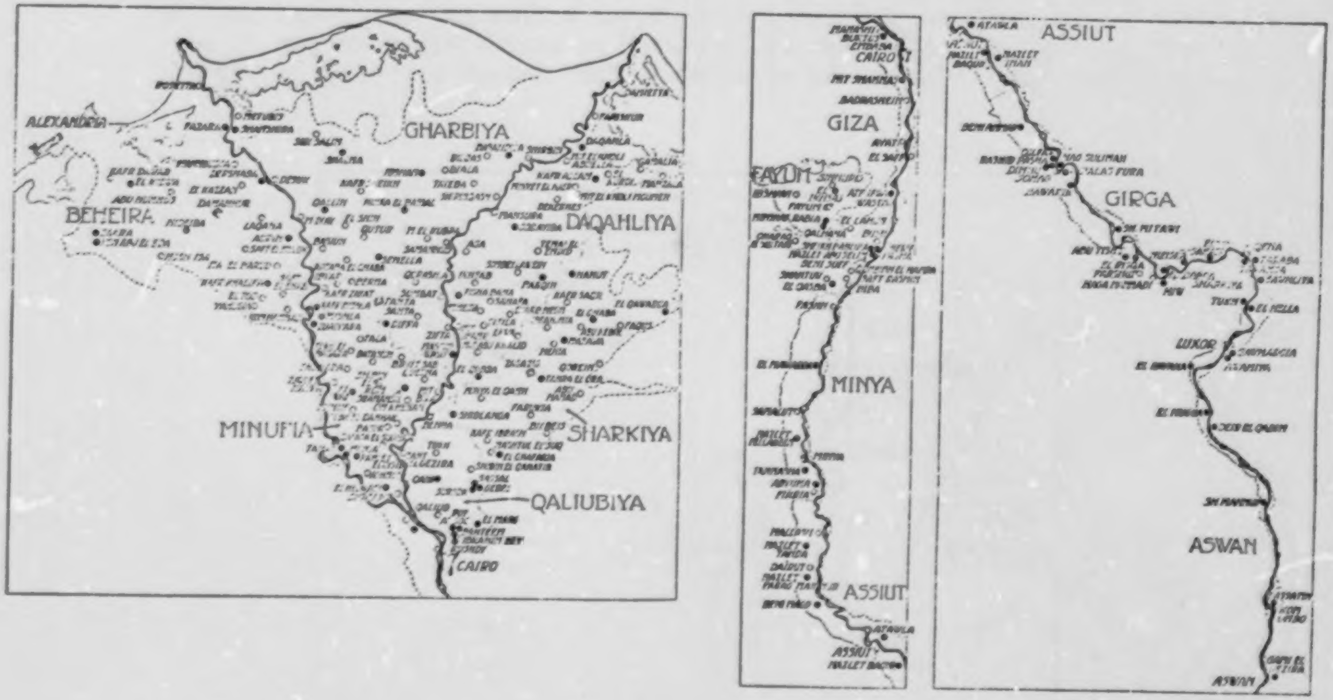

Figure 2. A map of Egypt, in three parts, divided roughly into Lower Egypt (Nile Delta), Upper-Middle Egypt, and Upper Egypt. The map was taken from Scott (1937) and dates from the 1930's. Since that time, the governorate of Gharbiya has been subdivided into Gharbiya and Kafr El Sheikh Kafr El Sheikh now comprises the northern sector. Girga has also been subdivided into Sohag, in the north, and Qena, in the south to Aswan.

in Egypt, who showed conclusive evidence that irrigation schemes grossly enhanced transmission. Table 1, taken from Khalil's study, shows the percentage of persons from four different villages infected with S. haematobium in 1934, before canals and pumps were installed, and in 1937, about three years after installation. Over a tenfold increase in schistosomiasis was observed. Villages over one kilometer away from the new canals had lower rates than those located nearby. The numbers of patients with schistosomiasis at the local hospitals also increased dramatically. Prevalence remained low in nearby areas which continued the ancient "basin" form of irrigation.

Table 1

Effects of Conversion from Basin Irrigation to Perennial Irrigation in Kom Ombo, Upper Egypt. After Khalil and Azim, 1938.

Village	Percent Positive With	
	1934	1937*
	S. haematobium	S. haematobium
Sebaiia	0	44
Kilh	7	50
Bimban	2	64
Mansouria	11	75

*Results obtained by examination of urine and stool specimens of 100 persons from all classes in 1934 and three years later after conversion of the area to perennial irrigation.

Basin irrigation predates all other forms of irrigation practices and does not create the environmental conditions suitable for snail proliferation. Under basin irrigation, the low flat lands on the banks of the Nile were flooded annually during the late summer. The local farmers (fellaheen) would trap the silt-laden flood waters using small earthen dikes. After the silt had settled out on the land, the water would be released. (This was only a slight modification of what occurred naturally.) The fields would be planted. This form of irrigation produced one crop per year, provided it flooded. Pumps and canals give the farmer an obvious advantage, and an impounded reservoir increases this advantage. Damaging floods can be better controlled and droughts alleviated. With an increase in available water, irrigation systems can be expanded to new lands and cultivation continued throughout the year.

During the last century and early part of this century, development programs were instituted in Egypt which included telegraph networks, railroads, harbor construction, and barrages(dams). Barrages located at Aswan, Esna, Naga Hammadi, Assyut, and at the Nile Delta created reservoirs for the expansion of irrigation schemes. Previous to this period, irrigation was primarily basin.

Nevertheless, by the 1930's the Nile Delta and the areas south of Cairo to Assyut (see map, Figure 1) were irrigated. Only the governorates of Sohag and Qena, along with parts of Aswan were not irrigated with more modern methods. Over 85% of the rural population were cultivating land under irrigation schemes that posed as sites for schistosomiasis transmission.

The first major perennial irrigation (perennial irrigation means year-round irrigation and has been the term used for irrigation other than basin) scheme, built during the latter part of the last century was located between the two branches of the Nile, the Rosetta and the Damietta, in the Nile Delta. It was a huge scheme involving the construction of an elaborate maze of canals and drains. Soon after its completion, the delta began producing its famous long staple cotton. Apparently the digging of the canals and drains took a brutal toll on the local peasantry. Thousands reportedly died, and where there presumably had been only very low levels of schistosomiasis infection, Scott (1937) found in the 1930's that over half the population in the Nile Delta was infected, and that in many areas the prevalence was over 90%. This apparent increase was quite dramatic and all subsequent attempts have failed to eradicate schistosomiasis. Lenoix (1958) elaborated on the relationship between irrigation engineering, the impoundment of streams, and schistosomiasis. Methods for controlling snail growth were suggested. Farooq (1966a) has shown evidence obtained from field studies in Egypt suggesting that the type and size of irrigation water courses and the proximity of the irrigation watercourse to the village are important factors in transmission. It was further suggested that the two different snail vectors, _Bulinus_ and _Biomphalaria_, favored different types of irrigation watercourses indicating that transmission of these two species of schistosomes occurs separately.

Impounded reservoirs, often indicated for irrigation expansion, also create new environmental conditions suitable for snail vectors of schistosomiasis to flourish. The shoreline frequently provides conditions similar to the sluggish waters of small irrigation canals and drains. The more convoluted the shoreline, the better.

It should be clear by now that the construction of the AHD and the formation of the Lake Nasser Reservoir, now approximately 450 kilometers long, could conceivably spread the snail vectors of schistosomiasis into the new habitats created by the dam and the related irrigation expansion, and, with them, the disease. Environmentalists, epidemiologists, and parasitologists have foreseen this problem. Evidence cited below from other man-made lakes supports their view.

Hira (1969) and Webster (1975) reported that schistosomiasis was low in the indigenous populations living along the Zambesi River in central Africa. Following construction of the Karbia Dam on the Zambesi and the filling of Lake Karbia, Hira (1969) found increased prevalence of schistosomiasis at several lake-side villages. In school children, 68.8% had become infected. Overall prevalence as high as 58% was noted.

In Ghana, McDonald (1954) outlined potential medical problems that could arise from the formation of Lake Volta, the world's largest man-made lake. Snail vectors were absent in the area to be inundated. Now, Obeng (1975) reports that the snail vectors are common in many places along the shore and that transmission is increasing. McDonald's concern was that eradication of snail populations, once they became established, would be difficult, if not impossible, due to the vast area of the lake.

The Kainji Lake in Nigeria has also created environs conducive for schistosomiasis transmission. Snail vectors were present before dam construction (Imevbore, 1975) but the extent to which the tribes living in the river valleys of this area were infected is not known. (Unfortunately, this is a typical situation in many tropical developing areas.) Dazo and Biles (1970) studied the resettlements located on the periphery of Lake Kainji, Nigeria and reported that 31% were infected. Follow-up studies a year later (Dazo and Biles, 1971) indicated that transmission was increasing. Similar findings have been made by Harinasta _et al._ (1972) at Nom Pong lake in Thailand, indicating that this is a problem of the tropics in general and not limited to Africa.

The Controversy

Armed with the knowledge that dams and irrigation schemes in Africa and in other tropical regions create new habitats for snail vectors, scientists and news reporters alike attacked the AHD as a potential disaster. The results of the project, it was speculated, would cause an astronomical increase of the disease in the population. The cost of this disastrous increase would negate any benefits of the project, namely the increased conservation of the water resources of the Nile and hydroelectric power. Van der Schalie (1960, 1963, 1972, 1974) repeatedly expressed grave doubts about the AHD project. In one article, evidence was presented that schistosomiasis had increased roughly seven-fold, and that this increase was the direct result of the AHD (Van der Schalie, 1974). These data, referred to by Van der Schalie, were collected by Dazo and Biles (1971) and are reviewed in the following section.

Farooq (1967) estimated that half of the population was already infected, i.e. 14 million infected of a total population of 30 million in 1967. In areas that were to be converted or reclaimed, Farooq expected the prevalence to increase from 5% to 70%, and calculated that 2.65 million new cases of schistosomiasis would result after the completion of the AHD project. Scott (1969), whose studies in 1937 were the source of Farooq's (1967) estimate, suggested that there would be at least one million new cases, but added that predictions as high as six million new cases had been made. Ayad (1966) warned that schistosomiasis would increase in the areas that were to be converted to perennial irrigation following the construction of the AHD. Heyneman (1971), in a general article on "mis-aid" to the third world, indicated that impounding the Nile had directly resulted in the spread of schistosomiasis in Egypt. Fogel, et. al., (1970) estimated that 60% of the population of Egypt would become infected in the early 1970's as the AHD complex was completed. Furnia (1975) stated that schistosomiasis was more prevalent now than ten years ago, "having been exacerbated by an increase of placid waters from the increased irrigation canals and Lake Nasser resulting from the high dam at Aswan." Carter (1969), McJunkin (1970), and Farid (1975) reiterated previous speculations. In the Cecil-Loeb textbook of medicine, Lewis (1971) says,

> Irrigation schemes may have serious ecologic consequences for the public health. In Egypt, schistosomiasis has always been endemic, not made worse by seasonal flooding of the Nile. But in areas of perennial flooding, such as in the delta, there is total infestation of the population. With the new Aswan Dam, there will be large new areas of perennial

flooding, which may greatly increase the spread of the disease.

Sterling (1972), writing in the popular press, is probably the one most responsible for bringing the "Aswan High Dam disaster" to the attention of the general public. Numerous news media articles have since appeared and, without fail, blame the AHD project for Egypt's schistosomiasis problem.

However, among all of the speculation, no mention was made in any context of the impact of the AHD project on the Egyptian Nubian population. Indeed, this is a small group, and this is perhaps the reason that the Nubians have been overlooked. Nevertheless, it was the Nubians who were the ones most directly and immediately affected, because these people lived in the Nile Valley south of Aswan, and had to be relocated before the lake began to fill. The original homes of the Nubians are now inundated by Lake Nasser. What was the prevalence of schistosomiasis before the Nubians were moved? What is the prevalence now that they have been resettled on a perennially irrigated agricultural plain, called Kom Ombo, just north of Aswan?

Research Objectives

The intent of this study is to assess the role of the AHD project on schistosomiasis transmission in rural Egypt and in the Nubian population. In order to do this, it was imperative to collect any and all available and frequently not-so-available pre-AHD information on the prevalence, distribution, and incidence of schistosomiasis in Egypt. A review of this kind has not been prepared since Scott's 1937 work, now 40 years out of date.

More specifically the present study aims to:

1) assess the status of schistosomiasis and related environmental health factors in the populations at risk, i.e. the downstream rural population and the Nubians,

2) show, using historical data and experimental results collected on prevalence, distribution, and incidence of schistosomiasis, the changes in the epidemiology of this parasite in typical rural sites downstream and establish secular trends,

3) illustrate the effect of irrigation practices, an important environmental variable, on the spatial and temporal distribution of schistosomiasis,

4) evaluate the role of village water supply in schistosomiasis prevalence and the impact of this parameter and other environmental parameters on transmission,

5) demonstrate the relationship between certain aspects of population dynamics and the spread of schistosomiasis in the rural sites, and

6) suggest future needs for surveillance and control strategies for this disease.

This study, by comparing current data amassed in Egypt with historical data, is designed to detect changes in schistosomiasis prevalence and distribution that may have been produced by the presence of the AHD complex. The rural populations living downstream from the AHD were analyzed separately from the Nubian population.

The Review of Literature in the next chapter analyzes past survey information in Egypt. It shows what has been accomplished in the past, it points to current needs in schistosomiasis surveillance in Egypt, and it serves as a baseline for establishing changing patterns of transmission. Thus, it is an integral part of the design the study.

CHAPTER II

REVIEW OF LITERATURE

Introduction

This review is a survey of all material, published or unpublished, from which data could be obtained on prevalence, distribution, incidence, or any facet of schistosomiasis transmission in Egypt. It includes the earliest material, dating from the 1800's. Frequently, historical data of this type on Egypt were unavailable at the University of Michigan and thus had to be acquired in Egypt. there is almost a total lack of data on pre-dam health conditions and information in other developing countries similar to Egypt where huge man-made lakes have been created or are currently being built. This unfortunate situation is stressed because dams are being built at an accelerated pace, and without knowledge of pre-dam health conditions very little measure of the impact of these projects on human health can be made (Waddy, 1966; McDonald, 1958; Standly and Alpers, 1975).

Obtaining historical data in Egypt poses its own problems; thus for the interested worker resource centers in Egypt have been listed in Appendix 1 as an aid to speed the preparation and documentation necessary to establish research needs, design, and priorities that are required before work can begin. Several important articles pertaining to this study were found in the Journal of the Egyptian Public Health Association. This journal has a very limited circulation in the United States, and is not indexed. Often individual issues were without a table of contents. It was only by perusing the entire set of more than 40 volumes, article by article, that important and contributing historical data were located. Indeed, this review, prepared originally in Egypt, constitutes a research endeavor in itself. As pointed out in the Introduction, the data reviewed in this section provide a baseline for establishing patterns of schistosomiasis transmission before the AHD was built. Therefore, an analytical assessment of this background data was necessary. Basically, an evaluation of the methodologies used by the different studies reviewed was made in order to highlight comparisons between different studies. Because of serious methodological differences, some historical sources had to be completely discarded as baseline sources, but nevertheless are included here for completeness.

It is remarkable that at this time no long-range policy exists that would serve as an outline of needs for research activities concerned with surveillance, prevention, or control of schistosomiasis in Egypt. Furthermore, no recent comprehensive assessment of past data on the occurrence of this disease exists from which strategies could be formulated. No overview of the extent or expected trends in schistosomiasis infections in Egypt has been prepared. To quote Omran, et al. (1962), "The use of epidemiological methods in Egypt has been so fragmentary and so disorderly applied that a large amount of data, which could have been collected, was missing. Collection, analysis, publication, and circulation of knowledge are far from being satisfactory."

It is hoped that this review will provide a basis for a more rational development of future work, and the problems referred to by Omran, et al. (1962) minimized. An inventory of historical data has been prepared and respective authors classified in a master chart. Table 2 is a list, by author, area, and date of publication, of works in which available prevalence information has been reviewed.

Background Work on the Prevalence of Schistosomiasis

Haematuria has always been common in Egypt. It was seen in the French armies led by Napoleon after the invasion of Egypt in the early 1800's. In the late 1800's, a number of hospital patients in Cairo were surveyed for schistosomiasis, and one-third were found infected. Between 1900 and the late 1930's, different surveys were carried out, mostly in the northern areas of Egypt, with different findings depending on techniques and analyses used. Table 3, taken from Azim's review (1935), cites these different investigators and their respective findings. Azim included his findings of a survey in the Nile Delta, shown in Table 4. These results were based on the number of individuals positive for either S. haematobium or S. mansoni in groups of 200 persons selected from each village listed in the table. The results showed that both forms were common. Azim (1935) also surveyed areas south of the delta where perennial irrigation had been installed. As shown in Table 5, S. haematobium was found, and at high rates, similar to those in the delta.

None of the findings cited in Azim's (1935) review are comparable, and the lack of methodological information render them inconclusive. Nevertheless, it seems apparent

Table 2
Summary of Prevalence Surveys for Bilharziasis in Egypt, by Area, Year, and Author

Area of Survey	Year	Author
Country-wide	1935	Scott
Country-wide	1955	EMPH-Wright
Nile Delta	1866-1935	Azim
Calyubiya	1936	Khalil and Azim
Qalyubiya	1952	Weir
Calyubiya	1954	Chandler
Qalyubiya	1956	Dimmette
Qalyubiya	1958	van der Schalie
Calyubiya	1959	Abdallah
Iflaka	1963	Sherif
Beheira	1966	Farooq, *et al.*
Beheira	1966	Bell, *et al.*
Kafr El Sheikh	1972	Hussein
Beheira	1973	Gilles, *et al.*
Calyubiya	1977	Alamy and Cline
Upper-Middle	1866-1935	Azim
Giza	1949	Khalil
Giza	1955	Zawahry
Assyut	1968	Hamman
Giza	1970	Abdallah
Beni Suef	1972	Hussein
Fayoum	1976	EMH
Giza	1977	Abdel-Salam and Abdel-Fattah

Table Continued

that the prevalence of both forms of schistosomiasis was high in the northern delta and that *S.haematobium* prevalence was high in the perennially irrigated areas of the south.

The association between the perennial irrigation systems and the spread of schistosomiasis was first clearly demonstrated by Khalil and Azim (1935) in Kom Ombo in Upper Egypt during this same period, as mentioned in the previous section. No *S. mansoni* infections were seen by the workers in this region of Upper Egypt.

Schistosomiasis in Egypt

A brief view of the data for the country as a whole is

Table 2
Continued.

Area of Survey	Year	Author
Upper Egypt	-	-
Kom Ombo	1935	Khalil and Azim
Sohag	1954	Nooman
General	1955	EMPH
Aswan	1966	Tuli
Aswan	1970	Satti
General	1972	Dazo and Biles
Old Nubia	-	-
General	1951	Dawood
General	1958	Rifaat and Nagaty
General	1964	Zawahry
New Nubia	-	-
General	1972	Dazo and Biles
Lake Nasser	-	-
Fishermen	1970	Satti
Fishermen	1971	Dazo and Biles
Fishermen	1972	Dazo and Biles
Fishermen	1974	Scott and Chu
Desert Areas	-	-
Dakhla Oasis	1952	Abdallah
Dakhla Oasis	1957	Azim
Dakhla Oasis	1957	Rifaat, et al.
Dakhla Oasis	1964	Rifaat and Nagaty
Wadi El Natrum	1964	Rifaat, et al.
Mersa-Matruh	1964	Rifaat

followed by a more detailed review of information available for each of the following sectors: the Nile Delta, Upper-Middle Egypt, Nubia, Lake Nasser, and the Desert Sectors (which have been grouped together).

Country Wide Prevalence Surveys

Only two surveys have been carried out in Egypt which sampled the entire country, excluding Nubia, Lake Nasser, and the Desert Areas and are comparable. The first was completed in 1937 by J. Allen Scott, and the second was completed in 1955 by the Egyptian Ministry of Public Health

Table 3

Surveys of Bilharziasis Completed Between 1866 and 1924 in Egypt
After M. A. Azim (1935)

Investigator	Year	Location	Bilharziasis in Post Mortem Exams		Stool and Urine Exams for Ova		
			Number Examined	% Positive Schistosomiasis	Number Examined	%positive *S. haematobium*	%positive *S. mansoni*
Griesinger	1866	KEAH*	363	32	0	0	0
Sonsino	1874	KEAH	91	46	0	0	0
Kaufman	1894	KEAH	500	33.3	0	0	0
Ferguson	1910	KEAH	1000	40	0	0	0
MacCallan	1914	Qalyubia	0	0	700	44	0
MacCallan	1914	Sharquia	0	0	1089	66	0
MacCallan	1914	Sharquia	0	0	832	71	0
Leiper	1915	Qalama	0	0	95	45.2	0
Leiper	1915	El Marg	0	0	54	90.8	0
Khalil	1923	Saft El Enab	366	83	366	74	34
Khalil	1923	Gonmeza	157	63	157	53	14
Khalil	1923	Nag Hammadi	260	75.2	260	77	0
Khalil	1924	Tuira	360	77	360	77	0

* KEAH = Kasar El Aini Hospital, Cairo

Table 4
Prevalence of Bilharziasis in the Nile Delta in 1935*
After M. A. Azim, 1935

Village	% Positive Urine		% Positive Stool	
	S. haematobium	S. mansoni	S. haematobium	S. mansoni
Nefisha	50	0	0	0
Bordain	62	5	1	61
Tel Kebir	71	0	2	77
Salhia	59	5	2	56
Kanayat	66	0	7	14
Goudaida	63	2	3	53
Sek el Abad	81	0	7	1
Shanawan	68	0	1	3
El Dair	34	5	0	3
Tana	70	0	3	7
Matarieh	24	0	5	7
Diarb Nigm	64	1	5	9
Kasria	50	3	2	59
Kourashia	63	3	2	62
Piala	68	1	1	82
Baltim	62	1	1	76
Et tod	43	1	3	46
El Ghaita	54	0	5	69
Abou Keir	13	0	5	1

*This table indicates that the ova of S. mansoni appear with a limited frequency in the urine, and the reverse can be seen for S. haematobium in the stool. Results are from the examination of 200 persons at each village.

Table 5

Prevalence of Bilharziasis in Areas
South of Cairo. After Azim (1935).

Village	Percent Positive With	
	S. haematobium	S. mansoni
Oussim	69	0
Kafr Ammar	73	0
Bolida	71	0
Abahaway	70	3
Senouris	69	4
Kosm Abu Radi	71	12
Ashmant	60	0
Beni Bekhit	70	5
Dashut	80	17
El Fant	61	17
Kefour	72	12
Sheikh Fadl	60	8

(EMPH, later to become the Egyptian Ministry of Health and to be referred to as EMH) and was reviewd by Wright (1973). In 1965 a third study was completed by the EMPH, but the results are of limited value due to the differences in methodology between this study and the previous two. Following a general review (See below) of these two surveys, details of these studies are elaborated on under the appropriate geographic subheading to illustrate points pertinent to the particular locale.

In 1937, Scott (1937) reviewed the previous studies and completed the first country-wide survey. Some 40,000 individuals were examined on a random house-to-house basis. Scott (1937) supplemented these data with results collected from over 2,000,000 examinations made at government treatment centers. In summary, Scott (1937) found that 60% of the population was infected with both forms and 83% with either one or both forms in the north and eastern sectors of the Nile Delta. In the south central delta, 60% were infected with *S. haematobium* and 6% with *S. mansoni*. In Middle-Upper Egypt, in areas under perennial irrigation, 60% of the population was infected with *S. haematobium*, and in those areas in Upper Egypt under basin irrigation, only 5% of the population was infected with *S. haematobium*. Figures 3 through 5 are maps showing the distribution of schistosomiasis according to Scott. *S. mansoni* had a distinct and limited geographical distribution in the delta, and *S. haematobium* was of low prevalence in the area south of Assyut but generally high elsewhere. By 1937, in the area north of Assyut (Upper-Middle Egypt) perennial irrigation schemes had been constructed and were by far the most predominant method of cultivation, as in the delta. In the area south of Assyut (Upper Egypt), the older method of basin irrigation was still the most common type practiced. The association of irrigation practice and prevalence of schistosomiasis found by Scott (1937) reinforced Khalil and Azim's (1935) observations. Later, Nooman, *et al*. (1974) also found an increase in prevalence of *S. haematobium*, from 5.6% to 71.6%, in an isolated area of Upper Egypt which had been converted from basin to perennial irrigation.

It is clear that by the late 1930's schistosomiasis was quite widespread in Egypt. Indeed, in the Nile Valley north of Assyut the prevalence of schistosomiasis in the population had no doubt reached a peak by this time. The conditions were ideal for transmission, as control programs did not yet exist (Farooq, 1973). The only aspect not clearly understood was, "Why was *S. mansoni* only located in the northern and eastern delta, and not parallel in distribution to *S. haematobium*?"

Scott (1937) summarized his findings nationwide to show that 47% of the population, which at that time was about 15.23 million people, were infected with either one or both forms of schistosomiasis. He considered this to be a very conservative estimate. He further pointed out that the population living in the area between Assyut and Aswan, estimated at just over 2 million, would come under increasing risk of being infected as plans had already begun to convert the area to perennial irrigation.

By 1955, the EMPH completed a follow-up to Scott's work (1937) using the same sampling and laboratory methods. The villages selected were also the same sites studied by Scott (1937) twenty years before. Some 124,253 persons were examined, more than three times the sample population examined by Scott (1937). Wright (1973) has reviewed the 1955 findings and compared that data with the 1937 data, as shown in Table 6. It is clear that:

(a) a fall in the overall prevalence of

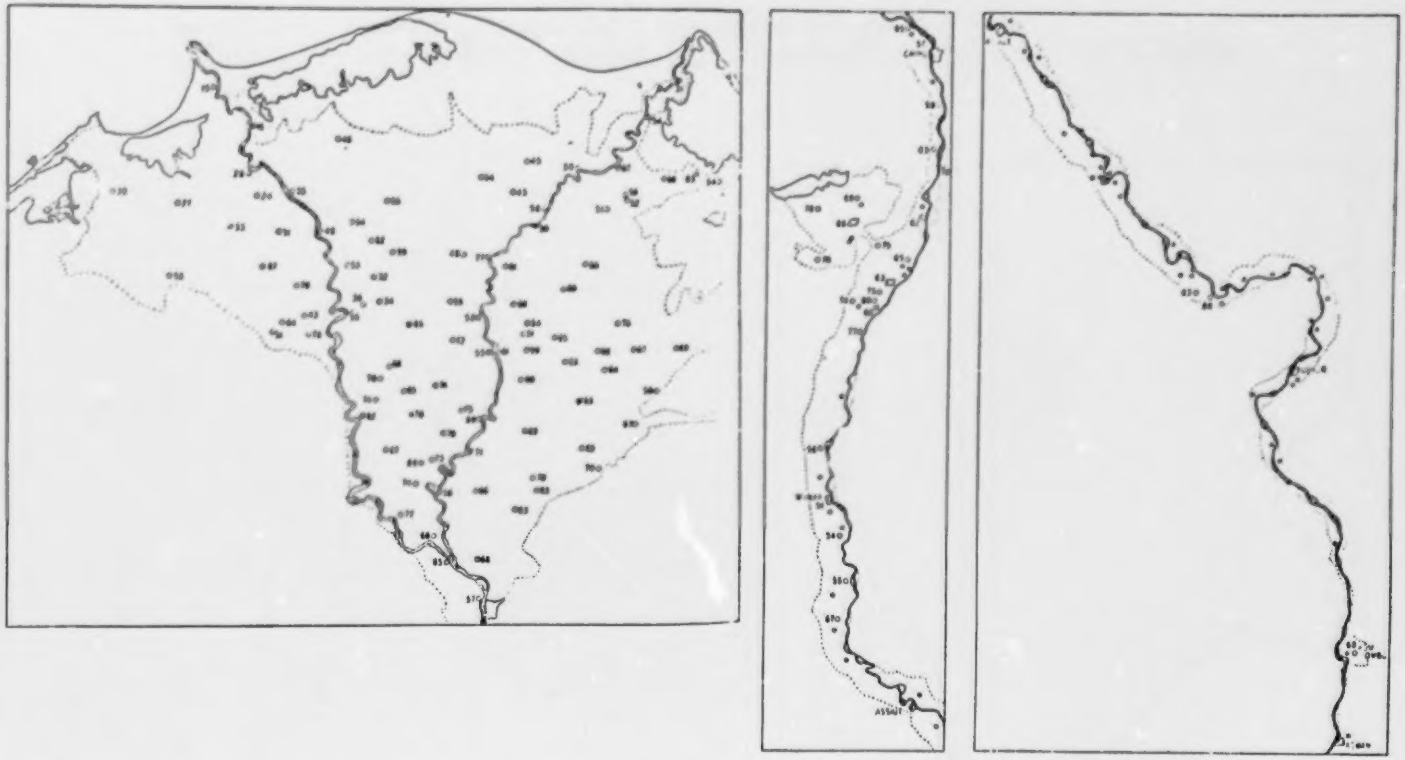

Figure 3. A map of Egypt taken from Scott (1937), that shows the prevalence per 100 of S. haematobium among persons examined at EMPH traveling hospitals during the 1930's.

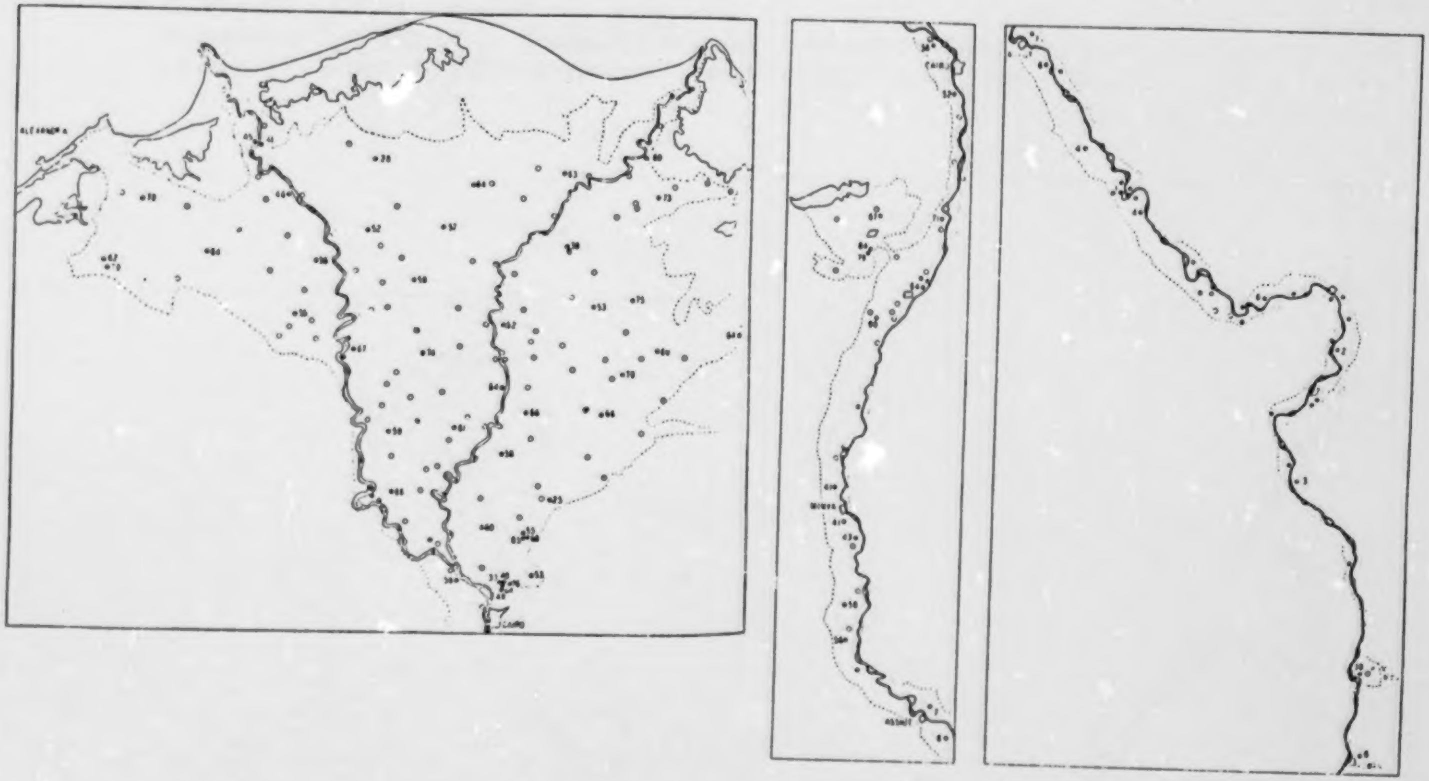

Figure 4. A map of Egypt showing the prevalence per 100 of S. haematobium among rural persons examined at their homes by Scott (1937).

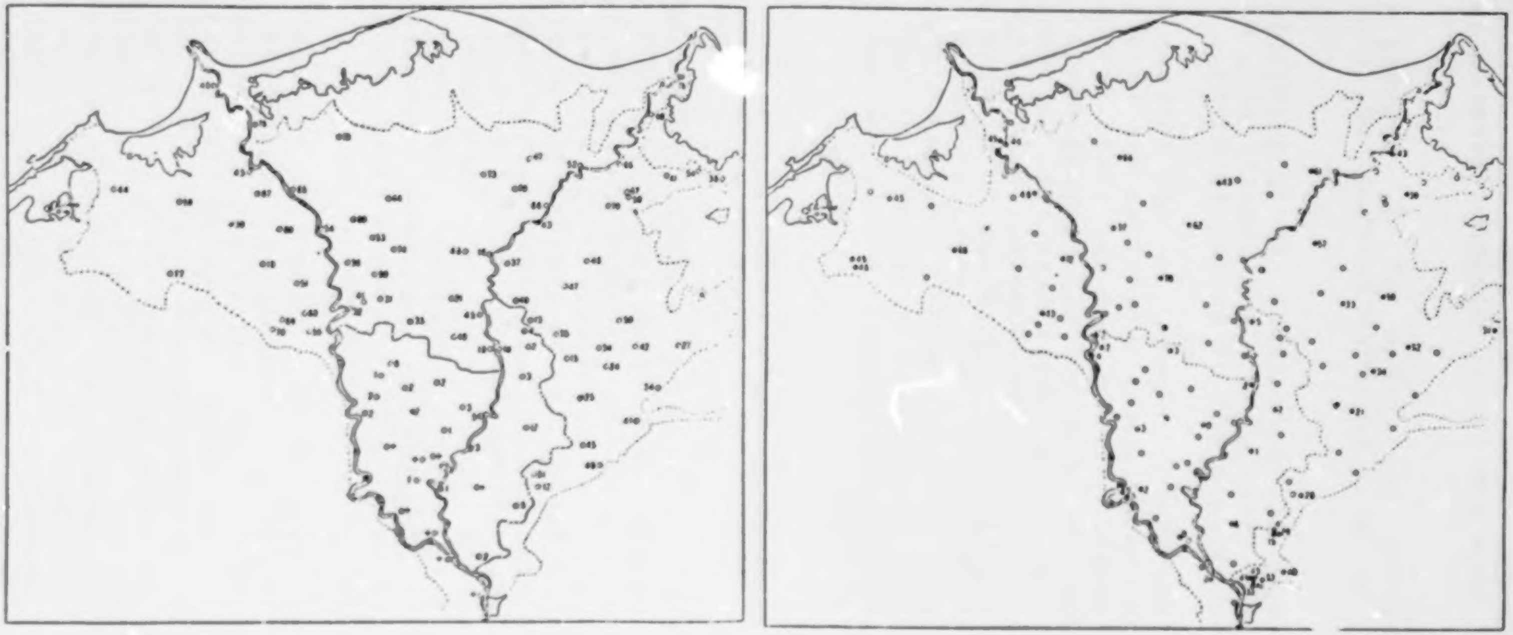

Figure 5. Two maps of the Nile Delta showing the percent prevalence of S. mansoni during the 1930's. The circles are results obtained by the EMPH traveling hospitals and the spots are results of Scott (1937).

S. haematobium, from 48% to 38%, and for S. mansoni, from 32% to 9%, occurred between 1935 and 1955,

(b) the decrease in prevalence of S. mansoni was consistent for all infected northern provinces, and

(c) while the overall prevalence of S. haematobium had decreased, there had been significant, even alarming increases south of Assyut in Suhag.

The results of the 1955 survey do not include the number of those persons with mixed infections and thus the total prevalence of schistosomiasis, or all those infected with either one or both species of Schistosoma cannot be calculated from this data. It is unfortunate that the design of the survey did not include this aspect. Those infected with both species of Schistosoma should not be ignored for it is this group which bears the greatest burden of morbidity and mortality (Scott, 1937). Halawani (1957) attributed the decline in prevalence from 1937 to 1955 to government anti-bilharziasis campaigns which, he pointed out, began in earnest in 1942.

Schistosomiasis in the Nile Delta

In 1936, Khalil and Azim (1936) showed both S. haematobium and S. mansoni prevalence to be high (55% and 59%, respectively) in a site 25 km NE of Cairo in the Nile Delta. A 4% sample of the population was selected and divided into two groups, depending on whether the selected individual was working near the village canal in the east or not near it in the west. Those working near the canal had somewhat higher prevalence of S. mansoni than those not working near the canal. No difference was seen in prevalence of S. haematobium between locations. Considerable differences were noted between sexes for both species, the males having the higher rates.

In 1952, Weir, et al. (1952), under the auspices of the EMPH and the Rockefeller Foundation, completed an intensive four-year study on the health and sanitation of the village of Sinbis, Qalyubiya Province, in the south central delta. In the course of the survey, the entire population, some 4,232 persons, was examined. An evaluation of the housing standards, water supply, fly control, latrines, and refuse disposal was made of the entire area. Data collected included the presence of lice and fleas, diseases of the eyes, nutritional status, vaccination status, serological examination for syphilis, enteric fevers, tuberculosis, malaria, and an examination of stools

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Table 6

Comparison of Results of Two Surveys, Scott (1935) and EMPH (1955), for Schistosomiasis at Different Regions in Egypt, after Wright (1973)

GOVERNORATE	1935 (Scott)					1955 (EMPH)				
	Examined	*S. haematobium* Positive		*S. mansoni* Positive		Examined	*S. haematobium* Positive		*S. mansoni* Positive	
		Number	%	Number	%		Number	%	Number	%
					Delta					
Beheira	2901	1543	53	1568	54	7473	2452	46	2305	31
Gharbiya	3095	1608	52	1196	39	12058	6131	51	2032	17
Dakahliya	1743	931	53	659	38	10518	5220	50	978	9
Sharkiya	2102	1384	66	575	27	6571	3437	52	322	5
Calyubia	3057	1879	61	791	26	14554	4478	31	435	3
Minufiya	1162	737	63	44	4	11709	5297	45	85	1
Subtotal	14060	8052	57	4833	34	62883	28016	45	6157	10
					Upper-Middle					
Giza	1148	617	54	7	1	8095	2726	34	273	3
Fayoum	1516	1340	89	1	0	10450	3966	38	0	0
Beni Suef	1191	981	82	0	0	6615	2399	36	0	0
Minya	3022	1371	45	0	0	8597	3331	39	0	0
Assyut	2546	548	22	0	0	9670	1537	16	0	0
Subtotal	9417	4857	52	8	0	43427	13959	32	273	1

Table Continued

Table 6: Continued.

GOVERNORATE	1935 (Scott)					1955 (EMPH)				
	Examined	*S. haematobium* Positive		*S. mansoni* Positive		Examined	*S. haematobium* Positive		*S. mansoni* Positive	
		Number	%	Number	%		Number	%	Number	%
					Upper Egypt					
Suhag	1633	51	3	0	0	12776	5377	42	0	0
Qena	1508	57	4	0	0	4138	176	4	0	0
Aswan	676	91	13	0	0	1029	239	23	0	0
Subtotal	3817	199	5	0	0	17943	5792	32	0	0
Total	27294	13138	48	4841	32*	124253	47767	38	6430	9*

*These two figures were calculated by dividing the number positive by the number examined in the delta governorates plus those examined in Giza. For the 1935 results the number examined was 15208 and for the 1955 results, 70978. In the governorates from Fayoum south, stools were not examined for *S. mansoni* ova.

and urine for parasites. High prevalence for both forms of schistosomiasis was found, 38.4% for S. haematobium and 12.5% for S. mansoni. Furthermore, on reexamination of a subsample, Weir found an even higher proportion of the population, 88%, to be positive for S. haematobium. This alarming demonstration of false negatives resulted from a change in methodology by Weir in the screening for S. haematobium. Routinely, S. haematobium is detected by an examination of the urine for characteristic ova. This is done simply by collecting the urine in a conical flask, allowing it to sit for a period of about half-an-hour, then examining the contents of the sediment by low power light microscope. The ova have a higher specific gravity than urine, and, if present, will be concentrated in the bottom of the flask. Because of the ease with which this test can be employed, it has been widely used.

Two methods were used to produce the increase in positives. In one of these, the urine was first concentrated by centrifugation and the sediment suspended in water, followed by projection of the specimen on a screen to search for hatched miracidia. In the second, rectal scrapings from each individual were examined for the presence of ova. The rectal scraping method of examination was found to be far superior in revealing infections. It is unfortunate that this method does not lend itself to mass screening procedure.

The implications of Weir, et al.'s (1952) demonstration of large numbers of false negatives are that

1) all the previous surveys had underestimated the prevalence of S. haematobium, and

2) when the simple sedimentation technique is employed an estimate of probable false negative error should be included in the results. A whole new light is thrown on Scott's (1937) estimates. Presumably the prevalence should be increased in areas from 60% to 80%. Certainly no less than half of the population was infected in 1937, when Scott's (1937) results were published: over 7.6 million in a total population of 15.2 million persons.

Weir, et al.'s (1952) study also suggests that S. mansoni was invading a new territory. A careful look at the maps in Figure 5 shows that in 1937 S. mansoni was almost non-existent in the south central area of the delta in which the village of Sindbis is located. Weir, et al. (1952) however, found a prevalence of 12.5%. Scott's highest prevalence found for the same area was only 7%, but it was usually much lower and frequently zero (1937). No data were collected for Sindbis itself by Scott (1937) in

1937, and, therefore , it is possible that the area could have been an isolated focus, or, even more remotely, an extension of infection from the not too distant south-eastern sector where S. mansoni was more common. A more likely explanation is that the higher prevalence of S. mansoni in Sindbis was the result of differences in technique by the surveyors. The rectal scrapings technique certainly would have reduced the number of false negatives, as compared to the more routine methods of examining the stool directly for S. mansoni ova as used by Scott (1937). Apparently Weir, et al. (1952) employed the rectal scraping technique only for S. haematobium detection (although it can be used for S. mansoni as well) and, like Scott, relied on the traditional method to screen for S. mansoni. A prevalence rate of 12%, therefore, may be too high to be explained just by differences in techniques.

Chandler (1954) carried out a follow-up on Weir, et al.'s (1952) study two years after its completion and found that the mass chemotherapy program implemented by Weir had reduced the prevalence of schistosomiasis to isolated cases. It is doubtful, however that the prevalence continued to remain low. Treatment does not reduce the risk of reinfection. Indeed, this has been one of the major frustrations of treatment control programs, i.e., after a course of treatment has been finished, it has been difficult to keep the cured patient free from the readily accessible snail-infested canals and drains.

Table 6 includes the results from the 1955 EMPH study for the delta sector and compares them alongside those of Scott's (1937) study. A decrease in S. haematobium prevalence from 57% to 45%, a proportional drop of 12%, can be seen for the delta. Decrease in prevalence is seen to be greater in some governorates than in others. For example, the decline was much greater in Qalyubia than in Gharbiya. What is remarkable is the very uniform decrease in prevalence for S. mansoni for all governorates in the delta, except in Minufiya, which was low to begin with.

Dimmette (1956), in a study to detect neoplasms of the bladder, found 31.7% infected with S. haematobium in a sample taken from the Qalyubiya Province census, which agrees remarkably well with the 1955 EMPH results. Qalyubiya was also the site for two other projects carried out between 1953 and 1959. In a review of these projects, Abdallah (1973) reports that Helmy from the EMH found that before treatment 44.5% of the population was infected with S. haematobium and 2.6% with S. mansoni. Treatment with tartar emetic reduced the figures to 30.4% and 1.1%, respectively, over a period of five years. The second project was a joint American/EMH effort by Berry and Halawani (1973) and was designed to assess molluscicicing only as a method of reducing schistosomiasis infection.

Only children between 6 and 19 years of age were examined. S. haematobium was reduced from 40.2% to 24.2%, and S. mansoni was reduced from 5% to zero during the eight-year period of the project.

It should be pointed out that prevalence of shedding of ova in the 5- to 9-year-olds is never the same as the prevalence in the general population, which is generally lower. This is true for both forms of schistosomiasis and is irrespective of the seasonal pattern of transmission (Farooq, et al., 1966). The age-specific distribution for schistosomiasis in endemic areas has been shown to be very characteristic. Figure 6 shows the sex-adjusted age-specific prevalence curves for four different surveys. The same pattern is shown in each one. The prevalence rises quickly in younger children, falls sharply in the teens, and then falls more gradually thereafter and generally levels off at a much lower rate in middle age. The younger groups, therefore, provide a more sensitive measure for control assessment, as they are the age group most frequently positive. Generally, prevalence differs according to sex, with males leading, especially those occupied as farmers or boatmen. Therefore, crude unadjusted data may differ by area depending solely on the structure of the population. For example, the prevalence may be artificially depressed in an area with more women, all other things being equal. Generally, this is not a problem in Egypt, because of the similarity of composition in the rural populations.

There is an exception. The population in Aswan and Nubia has a low male:female ratio resulting from male emigration to the northern cities for employment, leaving behind the adult females and children. This has been a continuous migratory pattern since the turn of the century. Currently, the trend has changed somewhat to moving the family nucleus as well. Labor demands from neighboring Arab countries contribute to the depressed ratio. Therefore, in this area crude rates might underestimate true prevalence.

Wright (1973) reviewed the results of urine examinations on 60,197 persons, which are shown in Table 7. The survey involved 23 different villages in various locations in Egypt to show the age-sex specific prevalence. This was a companion field study to the 1955 EMPH survey. Prevalence in males was slightly higher than in females and reached a maximum at 10 to 14 years of age. Both males and females showed the typical increase in prevalence during the early years, reaching a peak in the teens and tapering off after the early twenties--the classic age-sex distribution of schistosomiasis in Egypt.

Sherif (1968) found somewhat higher prevalence rates in Iflaka. Iflaka is in the Beheira governorate in the northwestern delta, where S. mansoni is also found. Sherif

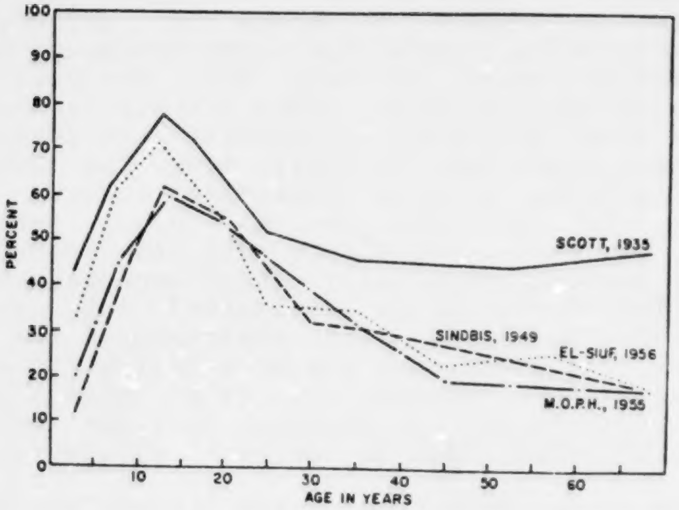

Figure 6. The prevalence of schistosomiasis in four surveys. After Omran (1973).

(1968) detected 63.2% with *S. haematobium*, [illegible] with *S. mansoni*, and 82.2 with either one or both; and termed the area "hyperendemic." These prevalence figures suggest a sharp increase since the 1955 EMPH studies for this area (see Table 6). Possibly Iflaka was an atypically high prevalence site, again reflecting the highly focal distribution of schistosomiasis. Another explanation for such an increase may be the result of differences in methodology. It is difficult to determine the exact cause of the differences based on the information available.

In 1966, also in the Beheira governorate, west of the Iflaka area, one of the most comprehensive studies of schistosomiasis in Egypt was completed. This was the joint WHO-UNICEF-EMH "Egypt-49" pilot control project, directed by M. Farooq (Farooq and Nielsen, 1966). Approximately 5% of a total population of 250,000 persons were examined. Socio-economic, environmental, and cultural factors, as well as domestic water habits, were included in the study, as was the examination of urine and stools for schistosome ova. The sample population was selected from four different sectors or divisions: rural, reclamation, urban, and control. The control sector served as a comparison site for the others in which measures against schistosomiasis were to be tested. Prevalence for one or both forms was high in the control sector (59.5%), in those who were occupied as farmers (50.6%), boatmen and fishermen (60.4%), in males in the 10-14 age group (84.4%), in those who could neither read nor write (32.2%), in those who swam (61.9%), in those who washed clothes and utensils in canals (50.2%), in those who lived in mud or mud brick houses (46.4%), and in those who did not have piped water (53%). The relationships between schistosomiasis prevalence, regardless of type, and the different independent variables follow very closely what might be expected, i.e., those who have most water contact, who are less educated, who have inferior housing, and who use the canals as a drinking and washing water source have higher prevalence rates than their counterparts. It was also expected that those who had latrines in their homes and used them would have lower rates (32.5%), than those who did not have latrines in their houses (47.9%). In addition, these results show that by far the lowest prevalence was found in these persons who have latrines in their houses but did not use them (10.8%). This somewhat surprising observation was found consistently throughout the project area in each division. A further analysis based on subject's age and type of house showed that the non-users were often very young children whose rates for schistosomiasis were generally low anyway. Age, however, was not the determining factor for mud brick or inferior houses for which the rates were again the lowest for those who had latrines and did not use them. In this analysis, the difference in prevalence between having a latrine and using it and not having a latrine was very small, and for the poorer housing, not

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Table 7

Prevalence of Urinary Schistosomiasis by Age and Sex Among 60,197 Persons Surveyed in 23 Villages in Different Locations in Egypt in 1955 by the EMPH, After Wright (1973).

Age Group (Years)	Males			Females			Total		
	Number Examined	Positive		Number Examined	Positive		Number Examined	Positive	
		#	%		#	%		#	%
0-1	38	0	0	35	0	0	73	0	0
2-4	866	120	14	768	165	21	1,634	285	18
5-9	4,642	2,343	50	4,478	1,951	44	9,120	4,294	47
10-14	4,296	2,929	68	3,782	1,977	52	8,078	4,906	60
15-19	3,223	3,013	50	5,372	2,017	39	9,987	3,374	56
20-29	4,615	2,310	50	5,372	2,017	39	9,987	4,381	44
30-39	5,213	2,098	40	5,602	1,501	27	10,815	3,599	33
40-49	3,826	1,058	27	3,867	753	19	7,693	1,801	23
50+	3,400	757	22	3,399	603	18	6,799	1,360	20
Total	30,199	13,618	45	30,078	10,382	35	60,197	24,000	40

significant. No truly satisfactory answer was provided.

It would have been worthwhile to examine the method in which the use or non-use of a latrine was determined. No elaboration of this method was available in this article. A definition must precede the formulation of the question, since observation seems unlikely, and it is this definition that must be analyzed, as well as the data. Results are directly affected by the methods with which they are taken, and without knowing the methodology employed, interpretation is difficult.

Another interesting relationship shown by Farooq, *et al.* (1966) was that between the age, sex, and swimming habits, and the prevalence of schistosomiasis. Infection with both species was twice as great among frequent swimmers as among non-swimmers. Much higher rates for swimmers were consistently found for either species or for schistosomiasis in all four divisions of the project area. Of the males who swam, 57.3% were between the ages of 5 and 19, and 53% of the female swimmers were between 5 and 14. Male swimmers outnumbered female swimmers four to one. The overall higher rates in young swimming males strongly suggest that this group's activities play an extremely important role in the continued transmission of schistosomiasis in Egypt.

Figure 7 shows the similarity of the age-specific prevalence for the different forms of schistosomiasis in the four different project divisions, again demonstrating the characteristic and universal pattern of high rates in the young and lower rates in the adults. "Bilharziasis" in this figure refers to those who are infected with one or both species of schistosomes and, as pointed out before, is synonymous with the term schistosomiasis. In the overall project area 29.7% had *S. haematobium* and 28.5% had *S. mansoni*. Prevalence of mixed infections (those infected with both) is always less than for either of the two or for "bilharziasis". In the overall project area 17.2% had both *S. haematobium* and *S. mansoni*, and 40.9% either one or both or bilharziasis. These results are summarized in Table 8. Significant differences were noted in the Egypt-49 study, not only between divisions, but also between villages, as well as between different parts of the village.

Even more recently, in the north central delta and in Middle Egypt, a project on health manpower sponsored by WHO and the High Institute of Public Health (Alexandria University) completed a survey in 1972 which included a measure of prevalence on several human parasitic infections. (Hussein, 1972). The sample population was selected systematically from a frame or list of all families in each of five villages in an area near the town of Kafr El Sheikh. Some 4,177 persons were selected, of which 13.4% were positive for *S. haematobium* ova in the urine and 15.4%

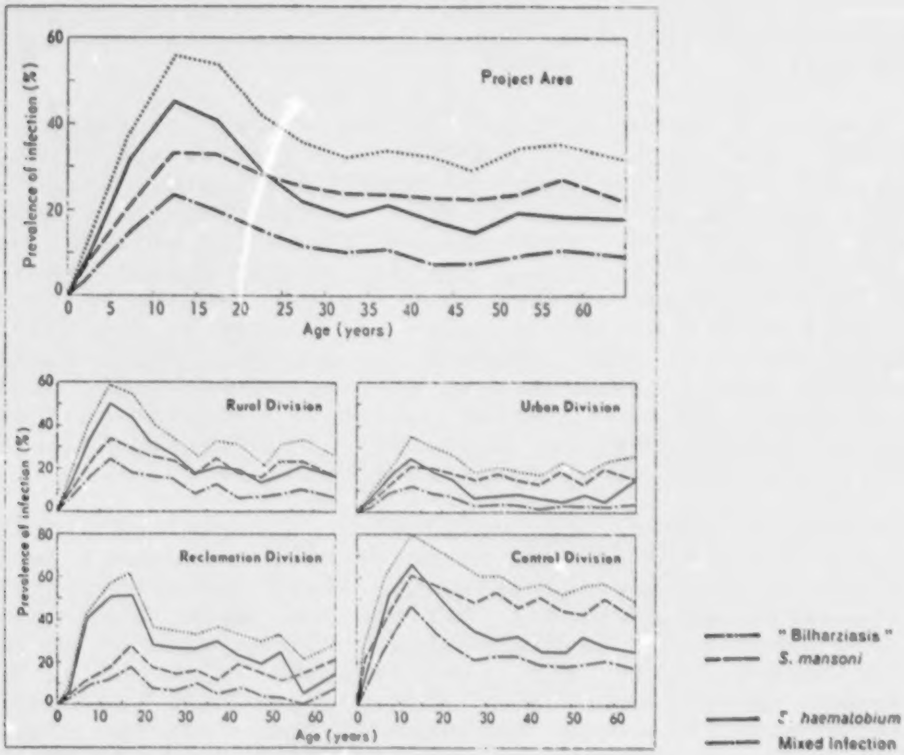

Figure 7. Age prevalence distribution of schistosomiasis in the Egypt-49 project area and in its four divisions. After Farooq, et al. (1966).

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Table 8
Corrected Estimated Prevalence of Bilharziasis in the Egypt-49 Project Area by Division*

Division	Population	Persons Infected with							
		S. haematobium		*S. mansoni*		both types		Prevalence of "bilharziasis"	
		No.	%	No.	%	No.	%	No.	%
Rural	91,562	29,100	31.8	24,800	27.1	16,600	18.1	37,000	40.7
Urban	72,897	10,600	14.6	12,700	17.4	5,700	7.8	17,600	24.1
Reclamation	17,746	6,100	34.2	3,200	17.9	2,000	11.0	7,300	41.2
Control	43,369	19,800	45.7	24,700	57.0	15,200	35.1	29,300	67.6
Total	225,574	65,600	29.7	65,400	28.5	39,500	17.2	91,500	40.9

*These prevalence figures have been corrected for the proportion of a subsample found positive in three examinations on consecutive days. After Farooq *et al.* (1966).

positive for S. mansoni ova in the feces (about 8% did not give a specimen). Table 9 shows the age-sex distribution of S. haematobium and S. mansoni infection in the selected population. Infection with either species followed a typical distribution with slightly higher prevalence in the males.

These findings are the lowest in prevalence so far seen for this area of the delta. If those individuals who did not give a specimen had been positive, then the prevalence would have increased to 20% and 23% for S. haematobium and S. mansoni, respectively. This is still, however, a decrease for S. haematobium when compared to the 1955 findings, which were 52% for this same area (note that Kafr El Sheikh was part of the Gharbiya governorate in 1955), and only slightly raised for S. mansoni. These findings suggest that the prevalence of S. mansoni has changed only slightly, and S. haematobium has decreased since 1955.

The most recent data collected in Egypt on prevalence and distribution of schistosomiasis was gathered in the Qalyubia governorate in 1976 by Alamy and Cline (1977). A systematic sample of every fourth household was selected from eight villages. Twenty-seven percent of the population was found to be infected with S. haematobium and 40.5% with S. mansoni. Egg counts of the respective specimens were made, which is frequently used as a measure of intensity of infection, e.g., the more eggs shed the more severe the disease. Relatively low intensity of infection was found for both species: a geometric mean output of 9 eggs/10cc urine for S. haematobium and 12.8 eggs/gram of feces for S. mansoni.

In 1955, the prevalence of S. mansoni was 3% and for S. haematobium was 31% in Qalyubiya. The decrease in S. haematobium prevalence of 4% is only a modest one and could be explained by a number of factors, including the typically focal nature of the distribution of the disease. The high prevalence of S. mansoni, and correspondingly low egg count, are, however, very important observations. Looking back at Scott's (1937) work (see Figure 4), just to the north and east of where the Nile branches into the Rosetta and Damietta is the area of Qalyubiya, where S. mansoni was also very low in 1935. This is the same area where the eight village sites selected by Alamy and Cline (1977) are located and where the prevalence of S. mansoni has now jumped from spotty isolated foci to a level indicating a major change, not only in prevalence, but also in distribution.

Alamy and Cline (1977) have scrutinized their work in an effort to explain the changes observed in the prevalence of S. mansoni. Some possibilities are: a) From snail

Table 9

Prevalence of Schistosomiasis in Kafr El Sheikh,
Nile Delta, 1972.
After Hussein (1972).

Age	*S. haematobium*						*S. mansoni*					
	Males			Females			Males			Females		
	Examined	Positive		Examined	Positive		Examined	Positive		Examined	Positive	
		Number	%		Number	%		Number	%		Number	%
5-9	259	39	15.0	244	28	11.5	261	40	15.3	246	27	11.0
10-14	278	63	22.7	288	55	19.5	279	64	22.9	294	60	20.4
15-19	205	48	23.4	203	39	19.2	207	43	20.8	204	47	23.0
20-24	100	30	30.0	141	16	11.3	103	16	15.5	144	14	9.7
25-29	92	19	20.7	146	16	11.0	95	7	7.4	149	15	10.1
30-34	93	24	25.8	122	12	9.8	94	12	12.6	122	11	9.0
35-39	127	19	15.0	152	20	13.2	128	12	9.4	154	13	8.4
40-44	119	18	15.1	114	9	7.0	119	14	11.8	115	10	8.7
45-59	215	31	14.4	194	7	3.6	215	20	9.3	194	9	4.6
60+	35	8	9.4	105	3	2.9	84	7	8.3	107	1	0.9
Total	1573	299	19.0	1709	205	12.0	1585	235	14.8	1729	207	12.0

studies done by Alamy and Cline (1977) in the early period of the study, it was shown that a much higher proportion of *B. alexandrina* to *B. truncates* snails could be found in the irrigation canals and drains of the studied sites. Quite the reverse was found in this same area by van der Schalie (1958). The current ratio of *B. alexandrina* to *B. truncates* found by Alamy and Cline (1977) was 24.5, whereas van der Schalie (1958) found a ratio of 0.104. This increase in *B. alexandrina* snails, the primary host for *S. mansoni*, may account for the increase in the prevalence of *S. mansoni* infection. b) A new technique for detecting *S. mansoni* ova was employed by the project. This technique, a modified formal-ether concentration procedure, has increased sensitivity of ova detection considerably over that which had been used in the past (Knight, *et al.* 1976). Alamy and Cline (1977) suggest that this is a principal factor in finding an elevated prevalence.

In conclusion, the prevalence of schistosomiasis in the Nile Delta has always been high, probably for almost a century, increasing at the time the delta was converted to perennial irrigation. *S. mansoni* has a more limited distribution in the north and central delta, whereas *S. haematobium* is found throughout. There is good evidence that *S. mansoni* is invading new ground in the south central delta in Qalyubiya, (Alamy and Cline, 1977) where it had previously been at very low levels. There is also evidence that the overall prevalence of schistosomiasis in the delta is declining. This is best illustrated in the Beheira governorate, where data from three surveys taken over a period of 31 years is available for comparison and is shown in Table 10. The overall prevalence is shown for 1935, 1955, and 1966 for *S. haematobium*, *S. mansoni*, and for either one or both infections (schistosomiasis). It declines continually for all cases from 1935.

Schistosomiasis in Upper-Middle Egypt

Frequently the environs south of Cairo, including the Giza plateau, are referred to as Upper Egypt. For purposes of presentation here, the area south of Cairo to Assyut will comprise Upper-Middle Egypt and will include the following governorates: Giza, Fayum, Beni Suef, Minya, and Assyut. Upper-Middle Egypt, as pointed out earlier, was, except for a few isolated areas, perennially irrigated by the 1930's. The region south of Assyut to Aswan, where basin irrigation was still predominant in the 1930's, constitutes Upper Egypt. The area south of Upper Egypt is called Nubia.

Less historical data on schistosomiasis exists for Upper Egypt than for the delta. One of the most common features of Nile Delta surveys was that they were located

Table 10
Percent Prevalence of Schistosomiasis in the Northwestern Nile Delta by Selected Years

Year	Percent Prevalence		
	S. haematobium	S. mansoni	Either One or Both
1935(Scott)	53	54	83
1955(EMPH)	46	31	--
1966(Farooq)	29.7	28.5	40.9

Prevalence of human schistosomiasis for the governorate of Beheira in 1935, 1955, and 1966. Prevalence data for infection with either one or both species of schistosomes for 1955 is not available. The data cited for 1966 have been corrected for the proportion found positive in three examinations on consecutive days.

within easy reach of either Cairo or Alexandria. Distances considered short in the developed world render many sites inaccessible in the developing world because of poor and/or crowded road conditions and inadequate communication systems. Moreover, a number of important survey support facilities can only be found in the larger metropolitan areas. Attempting surveys south of Cairo in Upper-Middle Egypt has been and continues to be a formidable logistic and administrative challenge that increases with distance.

In 1935, Azim surveyed a number of sites in Upper-Middle Egypt, as shown previously in Table 5. From each location, 200 persons were selected, presumably using an appropriate method, and examined for infection with S. haematobium and S. mansoni. The findings were uniformly high for S. haematobium infection. Unfortunately, it is difficult to determine the location of these surveys simply from the name of the village. Up-to-date maps of Egypt are either restricted or non-existent. Not only are many of the villages named in this survey not present on available maps, but repetition of village names is common.

Scott (1937) and the EMPH's 1955 study are the only investigations attempting to survey the whole of Upper-Middle Egypt. The coverage of both surveys, although spread throughout, was spotty. Scott (1937) supplements this with data collected from governmental treatment centers which, as it turns out, agree rather well with his findings, although different sampling methods were employed. Only S. haematobium infection was found. As has been stated, S. mansoni was not found in the southern delta or south of Cairo. The prevalence of S. haematobium ranged from 41% to 90%, with an average of 60%. Figures 4 and 6 show the distribution of S. haematobium obtained from the random house-to-house survey and from the treatment centers for the area between Cairo and Assyut. The notable uniformity is the result of widespread use of perennial irrigation throughout the area, which had been established sometime before Scott's study (1937).

Table 6 shows the results of the 1955 EMPH survey compared alongside Scott's (1937) results. The overall prevalence declined from 52% in 1935 to 32% in 1955. A decline was also seen in each governorate. In Giza, both in 1935 and 1955, sporadic cases of S. mansoni were found. Local health officials claimed that infection with S. mansoni in Giza or in any governorate south of Giza can be assumed to have been acquired from the northern delta. This assumption is becoming increasingly risky to make, especially in light of the recent evidence from Qalyubia, where the distribution of S.mansoni is clearly changing. Other more localized surveys have been carried out in the Fayum, Giza, and in Assyut.

In 1955, Zawahry selected a random sample of children from 0-12 years old, based on a 1954 social census frame in Shubramant, Giza (Zawahry, 1962). A sample of 762 children were selected, of which 691 gave specimens, 71 others moved or died, and 43 results were inadvertently lost. (It should be noted that such detailed accounting of the selected population is frequently overlooked when data are presented, and correspondingly the analytic value of the results is limited.) Helminthic and protozoan parasites were screened from the urine and stool specimens. Of the males, 25.9% were infected with S. haematobium. No S. mansoni infections were found.

In addition, Zawahry (1962) made an interesting observation. He found that the bilharzial children had a greater likelihood of having a multiparasitic infection. That is, the prevalence of infection with another parasite was higher in those children with S. haematobium infection than in children who did not have bilharziasis. It would be interesting if this relationship is true also for S. mansoni infection, and if other specific parasites were involved.

Abdallah (1973), in 1970, surveyed a nearby area of Giza, Shanbari, and found 31.2% infected with S. haematobium. The survey was carried out in connection with a control project measuring the effectiveness of hycanthone as a chemotherapeutic. No molluscicіding was done. A reduction to 20% over a year's time was achieved.

The Fayoum is an area of 400,000 feddans and can be seen on the map in Figure 2 as a bleeb of the Nile to the west, south of Cairo. The water for this area is supplied through a single source canal (Bahr Youssef) which branches into almost 40,000 km of irrigation canals. In 1949, Khalil (1949) surveyed 2-6 year-old children in the Fayoum, of which he found 65.1% infected with S. haematobium. The number of those examined for each age, the number of positives, and the percentage positive are shown in Table 11. A characteristic increase can be seen with the advance in age up to 6 years. In 1968, 45% of the population of about 880,000 persons were infected with S. haematobium. No S. mansoni infection has ever been detected in those who had never travelled outside the Fayoum.

Table 11

Age-Specific Prevalence of S. haematobium in the Fayoum, 1949. After Khalil (1949).

Age (Years)	No. Examined	No. Positive	Percent
2	20	5	25
3	51	26	51
4	68	38	56
5	96	65	77.6
6	112	92	82.1
Totals	347	226	65.1

Scott (1937) had found a somewhat higher prevalence in the Fayoum: between 67-84%. Since 1968, the Fayoum has been the site of a massive, and apparently successful, control project, carried out in cooperation with the EMH and the German Federal Republic. Prevalence has been steadily reduced to 8.1%, its present rate (Mobarkic, 1975). It was convenient that an effective application could be made at the Bahr Youssef Canal, just before it enters the Fayoum and branches, thus avoiding a piecemeal application to the 40,000 km of canals. Niridazole was used for mass treatment of the population with emphasis on the school children. The health units and primary and secondary schools were employed for administration of treatment. This effort continues as an ongoing control program as of this writing.

It will be interesting to follow the dynamics of S. haematobium eradication. When prevalence is plotted against year, the curve seen in Figure 8 has a shape which suggests one of diminishing returns. In the Fayoum, 8.1% corresponds currently to about 89,000 persons in a population of 1.1 million, which is a sizeable reservoir of infection.

In the Assyut area, four villages were surveyed in 1968 by Hamman, et al. (1975). This study was the most recent of those concerned with demonstrating the relationship between irrigation systems and schistosomiasis transmission. Systematic samples were taken at the study sites, and urine specimens were examined by simple sedimentation. A prevalence of 34.5% was found in the three villages located in areas that were perennially irrigated. In a fourth village, where basin irrigation was still employed and, according to Hamman, et al. (1975) the only village of its kind remaining in the Assyut governorate at the time of the study, the prevalence was only 3%. (It is not clear what Hamman, et al. (1975) means by "basin irrigation". The flooding of the Nile River in Egypt had ceased altogether by 1964, when the coffer dam at the downstream diversion canal was dynamited and Lake Nasser began to fill. After 1964, the annual flood, necessary for basin irrigation, was trapped by the rising water of the new lake.) When this village is included with the other three villages, the combined prevalence is 25%. In the 1955 EMPH study, 16% of the sampled population of Assyut was positive for S. haematobium which is 36% less than Hamman, et al.'s (1975) findings of 25%. However, the prevalence in the three villages with perennial irrigation schemes, i.e. 34.5% is probably more representative of Assyut as a whole and indicates an even greater increase.

In 1955, three of the villages sampled by the EMPH study were still using basin irrigation and had correspondingly low prevalence, which, when added together with the findings from the villages using perennial irrigation, resulted in depressing the overall prevalence given for the area. Apparently, the selection of the village sites by the two studies reflected different research objectives. A more meaningful comparison might be one where prevalence only in the villages using perennial irrigation is used. The prevalence data for 1955 for only those villages in Assyut using perennial irrigation comes from a separate parallel study by the EMPH in which methods

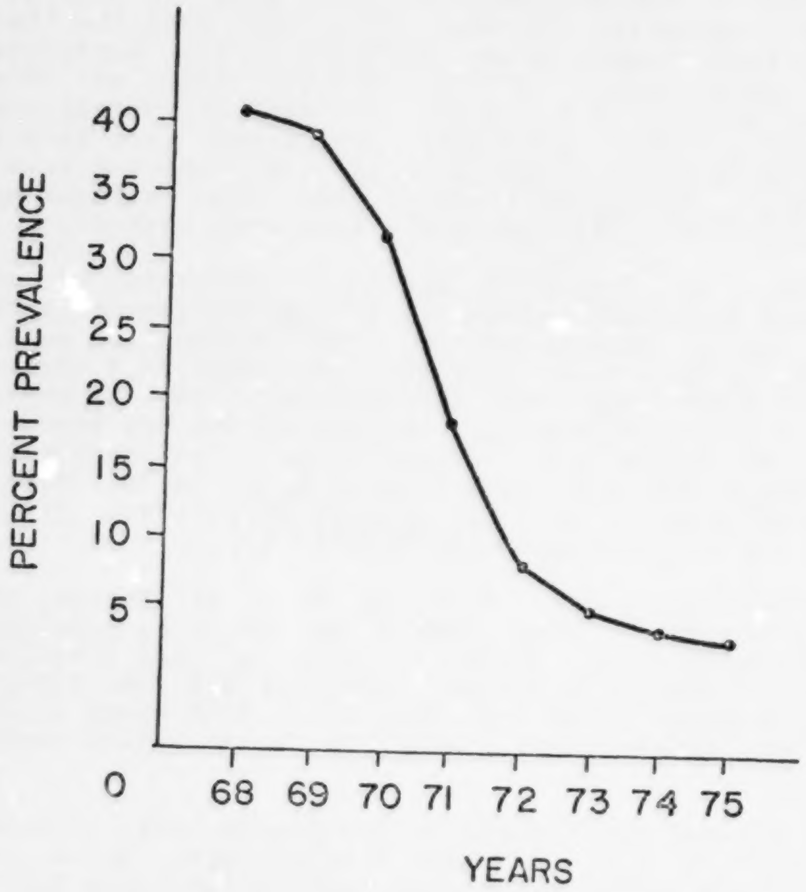

Figure 8. This graph was plotted after data obtained from the EMH (1975) for the Fayoum governorate schistosomiasis control project. The first year of the control program was 1968.

of irrigation and the prevalence of schistosomiasis were, like Hamman, et al.'s (1975) study, also being evaluated (Wright, 1973). The results of that study showed 68% out of 19,043 persons examined were infected with *S. haematobium*, or twice that found in 1968.

Increased use of perennial irrigation systems results in increases in schistosomiasis prevalence in Assyut. In the Assyut governorate between 1955 and 1968 the limited amount of land under basin irrigation was converted to perennial irrigation. It is possible that an overall increase in prevalence followed, but that the prevalence at any given site under perennial irrigation over this time period may have been dropping. If this had not been the case, Hamman, et al.'s results for the villages using perennial irrigation in 1968 would have been higher.

As part of the 1970 WHO-High Institute of Public Health study mentioned previously in the section on the Nile Delta, a sample population of 3229 persons was selected systematically from five villages near Beni Suef (Hussein, 1972). The study site is approximately 150 km south of Cairo in an area southeast of the Fayoum and has been under perennial irrigation from before 1935. The prevalence of *S. haematobium* for all five villages was 24.1%. Thirteen persons were found to have *S. mansoni* infections. Figure 9 shows the age-sex prevalence distribution.

Like the parallel study in Kafr El Sheikh, these results indicate that the prevalence of *S. haematobium* is also declining in Beni Suef, especially when compared to Scott's (1937) findings in the 1930's of 82% (see Table 6). The 32% prevalence found by the EMPH 1955 study might be taken as an intermediate point in a long-term downward trend.

Sex related differences in prevalence have, of course, been recognized for a long time, with males being significantly higher. The reason most often cited for this is that the males are at higher risk due to the occupational necessity of having increased water contact in the agricultural fields. This is not an entirely satisfactory explanation for the difference. Marked differences can be seen in the very early years, and in the adult age group the difference in prevalence between the sexes often is not as much (Farooq et al., 1966; Hussein, 1972). In the Egypt-49 project (Farooq,et al. 1966) and in the Kafr El Sheikh study (Hussein, 1972) the differences in prevalence between the two sexes were less than six percentage points. However, in Beni Suef the prevalence in males was more than twice that of the females, 32.3% and 15.5%, respectively. A similar observation was made by Hamman, et al. (1975) in Assyut. Differences in prevalence in male and female by region cannot be analyzed from data collected by Scott (1937) or

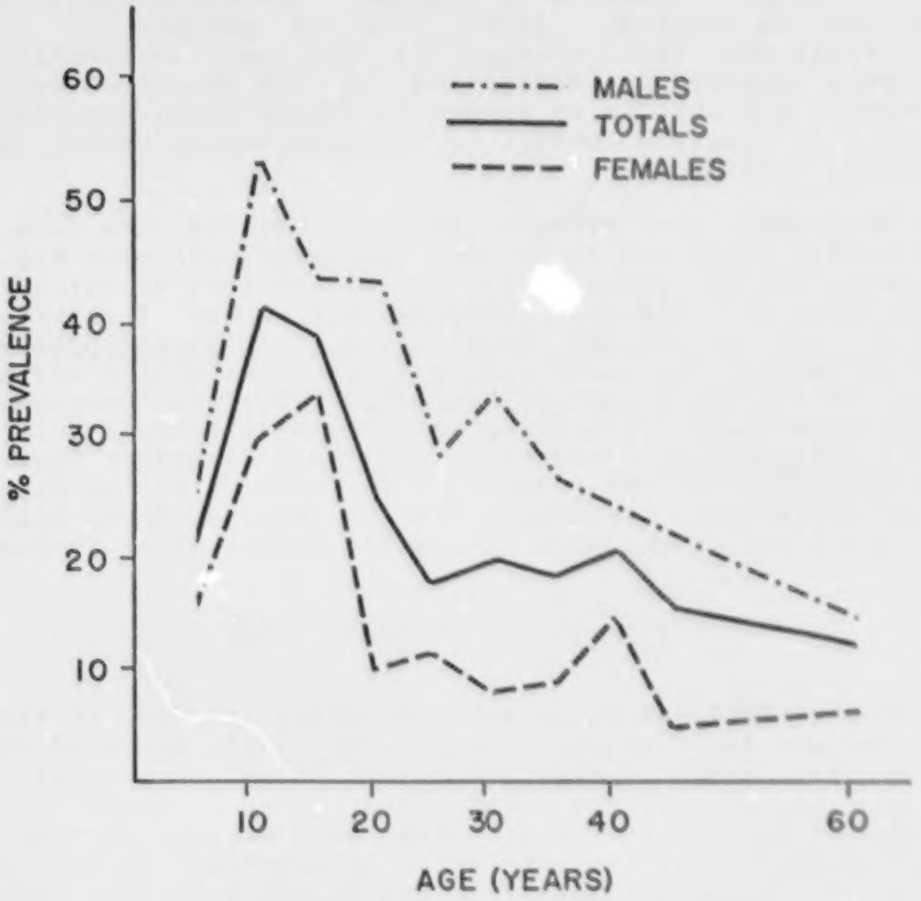

Figure 9. The age-sex specific prevalence of S. haematobium in selected sites of the Beni Suef governorate in 1972. After Hussein (1972).

the 1955 EMPH study (Wright, 1973). Both studies combined their findings from different regions of Egypt when presenting sex-specific data. This is unfortunate, for it would be interesting to see if a sex-related differential was developing over time.

There is an obvious need here for sex-specific data to be collected and presented in a manner that would facilitate comparison by region. There are no answers or even implications of what changes in sex-specific prevalence might mean (perhaps an indication of the impact of health education), but this is no reason to ignore them, especially when this is simply a matter of research design rather than additional field work.

In brief, the surveys carried out in the area of Upper-Middle Egypt are in general agreement with each other. S. mansoni was not present or, if so, could be explained by showing that the infected persons had spent time in the delta or had originated from there. S. haematobium was found uniformly throughout the area at a prevalence similar to that of the delta and reflected the widespread conversion of land from basin irrigation to perennial irrigation. In fact, S. haematobium infection had been abundant from at least the middle of the 1930's. In the future, the Fayoum must be considered separately as an area of Upper-Middle Egypt where schistosomiasis is rapidly coming under control.

Schistosomiasis in Upper Egypt

The area of the Nile between Assyut and the old Aswan Dam is termed Upper Egypt. When Scott (1937) surveyed this area in 1937, basin irrigation was practiced throughout the district except in the Kom Ombo plain. Large sugar plantations were developed in Kom Ombo during the 1930's, requiring the conversion of land to perennial irrigation. The Kom Ombo plain is similar to the Fayoum aneurysm, except that it is smaller in area and bulges to the east, not the west. The Kom Ombo plain is not as "pinched off" from the Nile as the Fayoum and is watered by numerous different canals rather than a single canal as in the Fayoum. Figure 10 is a LANDSAT photograph of Kom Ombo, Aswan, the AHD, and a northern portion of Lake Nasser.

Khalil and Azim's (1935) research into the causal role of perennial irrigation schemes, pumps, and canals in the "introduction of infection with S. haematobium" was carried out in Kom Ombo in the early 1930's. Khalil and Azim (1935) surveyed villages before and after conversion to perennial irrigation and found that prevalence reached levels similar to that of the delta in as little as three years following conversion. These results are shown in Table 1.

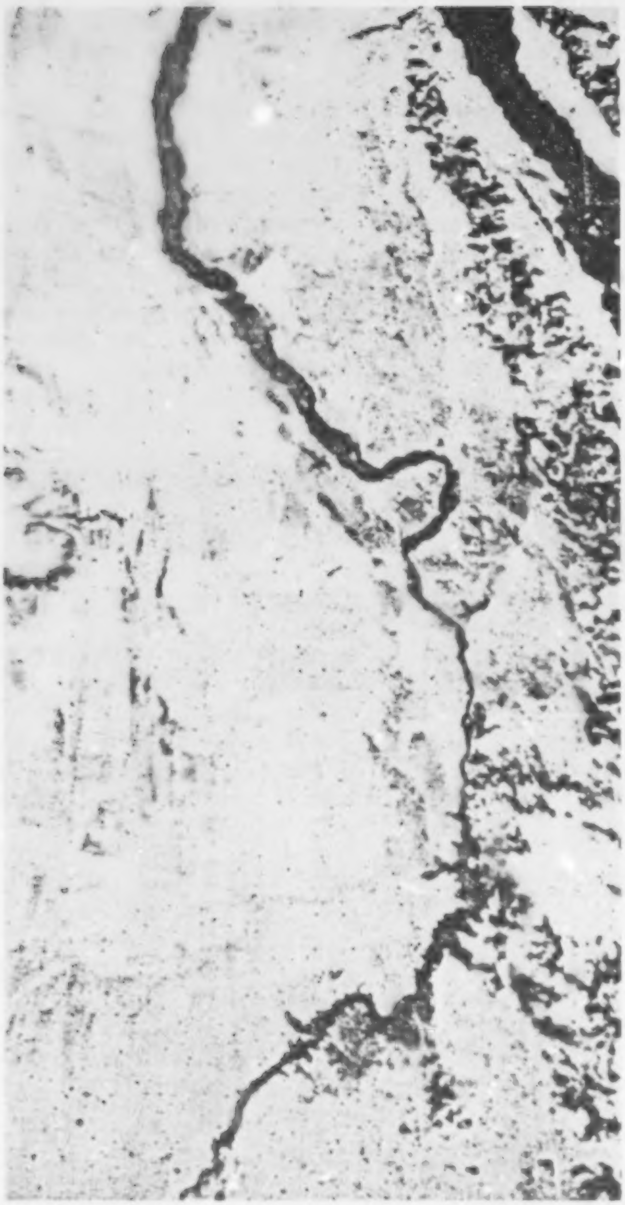

Figure 10. This is a photographic reproduction made by a LANDSAT satellite of Upper-Middle and Upper Egypt. Included in the lower portion is Lake Nasser. Just north of Lake Nasser is Aswan and the Kom Ombo plain.

Scott (1937) found in 1937, however, that the areas north and south of Kom Ombo had a very low prevalence of S. haematobium. Again, no S. mansoni was seen. The previous Figures 4 and 6 show this distribution, which included the results taken from governmental data. Generally, the prevalence of S. haematobium was 5% or less in Upper Egypt.

Data from the EMPH 1955 survey as shown in Table 6 reveal some of the most dramatic increases in prevalence so far seen. In two of the three governorates of this region, Sohag and Aswan, the prevalence increased considerably, while in Qena it remained unchanged. The increase from 3% to 41% in Sohag reflects the conversion of the governorate to perennial irrigation previous to the 1955 study. Large proportions of the Aswan governorate were also converted to perennial irrigation, which already included the Kom Ombo agricultural plain. Correspondingly, the prevalence increased from 13% to 23%. The increase probably would have been greater had the remaining portions of the governorate still using basin irrigation (the northern part of the governorate and south of the Kom Ombo plain) been converted.

Between 1955 and the 1960's, the Qena governorate, which was predominantly basin irrigated, and the remaining areas of the Aswan governorate under basin irrigation, were converted to perennial irrigation. What has happened in these areas since then is probably what everyone expects, but little current information exists except for an unpublished WHO report by Dazo and Biles (1972). Although unpublished, the report has been widely circulated and even quoted as evidence of the impact of the AHD on the increase of schistosomiasis prevalence (van der Schalie, 1972).

In this influential study, sites were selected in Assyut, Idfu (50 km north of Kom Ombo), the Nubian resettlement sites of Kom Ombo, and in the Aswan area. No sites were selected from urban areas or from the Qena governorate. In the area of Assyut, S. haematobium was found in 30% of those examined from two villages. In Idfu, an overall prevalence of 75% from three villages was obtained. From the three villages surveyed in Aswan, a prevalence of 32.4% was found, and for Nubia a combined prevalence of 19% was observed. These results are summarized in Table 12.

Certainly these findings show an increase compared to the level of prevalence seen in the 1930's. An increase was expected since there had been ample time since the conversion to perennial schemes for prevalence to increase when Dazo and Biles (1972) carried out their survey. There are, however, certain aspects of this survey that render the results epidemiologically unsound. First, it is obvious from a brief examination of the data that the method of selection did not provide a representative sample population

Table 12

A Summary of Results Taken from a Survey
for *S. haematobium* in the area Between Assyut
and Aswan in 1972 by Dazo and Biles (1972)

AGE-GROUP	MALES		FEMALES		TOTAL	
	# EXAMINED	% POSITIVE	# EXAMINED	% POSITIVE	# EXAMINED	% POSITIVE
0-4	31	6.0	21	5.0	52	5.8
5-9	245	29.0	148	20.0	393	25.7
10-14	384	59.0	193	32.0	577	50.3
15-19	177	60.0	58	31.0	235	53.1
29-24	37	30.0	43	12.0	80	20.0
25 +	15	13.0	57	4.0	72	5.6
TOTAL	889	47.2	520	22.7	1409	38.0

for age or for sex. The younger age groups were greatly over represented in the sample, and, as pointed out earlier, in Upper Egypt, especially in Aswan, adult females far outnumber the adult males in the general population. There was not a single village surveyed by Dazo and Biles (1972) where more women were selected than men. That could possibly have been corrected by appropriately weighting the selected population for age and sex. This, unfortunately, was not done. The major difficulty, however, is one of non-response and self-selection. If 100 persons are selected, using an appropriate method, and results are obtained for only fifty, the non-response rate is 50%, or the number not giving results/total selected X 100. To give only a typical example, in the village of Mankabael near Assyut, there are 13,000 inhabitants. All those between 2 and 25 years old were requested to give a urine specimen. A total of 123 responded and gave specimens. Based on their method of selection this is over a 99% non-response rate. It cannot be presumed that the non-respondents are typical of and similar to the respondents.

It would be very worthwhile to have recent quantitative data for Upper Egypt. However, the results from Dazo and Biles (1972) and of Tuli (1966), who completed a limited survey in Aswan, only indicate that S. haematobium is present. The exact proportion of the population infected cannot be determined with any certainty from these reports.

In brief, very little recent or accurate data is available for Upper Egypt. The prevalence of S. haematobium was low in the area prior to the use of perennial irrigation, but the entire area has since been converted to perennial irrigation. It is expected that S. haematobium infections would greatly increase following the conversion to perennial irrigation systems, and data provided by Dazo and Biles (1972) and also by Tuli (1966) indicate that it has. The exact figure of increase and when it occurred remains, however, unknown.

Schistosomiasis in Nubia

Egyptian Nubia was formerly the area along the Nile Valley between the old Aswan Dam and the Sudanese border, now inundated by Lake Nasser. The population from this area is quite distinct from the general Egyptian population, having different styles of dress and language. Three separate tribes, the Kenuz, the Arabs, and the Mahas or Fadiga, comprised about 50,000 persons. All were resettled in New Nubia in 1964 when the rising waters of Lake Nasser began to flood their original home sites. New Nubia has been constructed along the eastern periphery of the Kom Ombo agricultural plain. The villages retain their original names and geographical distribution, with the Kenuz in the north, the Arabs in the middle, and the Mahas or Fadiga in the south. Often neighbors were settled with neighbors. But a population living along 400 km of river bank is now compressed into an area approximately 50 km long bordered on one side by a canal. Figure 11 shows this resettlement pattern.

Dawood (1951) recognized that bilharziasis, transmitted by snail vectors, was present in Nubia but did not provide data on distribution or prevalence of the infection. Rifaat and Nagaty (1958) surveyed the Nubians for a number of health parameters, including schistosomiasis. Seven villages were surveyed, and some 553 urines were examined. Table 13 shows these results. Table 13 also shows to which tribe the village belongs and whether or not perennial irrigation schemes were present. It is interesting to note that perennial irrigation schemes were being installed at this early date in Nubia. Also shown in Table 13 are the number examined at each village, the number positive for *Schistosoma* ova in the urine, and the percent positive. An overall prevalence of 40% was obtained. Table 14 shows the age-specific prevalence rate with the younger members having a typically higher prevalence. Table 14 also shows the number of each age and sex who were examined. It is quite evident that the females, especially in the older age groups, were under-represented. Rifaat and Nagaty's (1958) survey suffers from the same defects that were found in the study by Dazo and Biles (1972). Not only is the population incorrectly represented, but the method of selection is not discussed , making it impossible to know the probability of being selected. It is known that 1369 persons were, by some unknown method, selected and that 553 gave urine specimens, which is a 40% non-response for specimens alone. Accordingly, these results cannot be taken as accurate estimations of the prevalence of schistosomiasis in the Nubian population at that time.

It is very fortunate that a survey just previous to the resettlement of the Nubians was carried out in 1964 by Zawahry (1964) in which the shortcomings of the previous surveys, and those of many of the surveys of Egypt, were avoided. A multi-stage stratified random sample based on the 1960 population census representing each of the three tribes was the frame for sample selection. Every individual in the Nubian population had a chance of being selected. This chance was calculated as a probability, which is the basis of any sound statistical analysis of survey data. From these prevalence figures estimates can be made with given degrees of confidence.

An overall estimate of 15.2% of the Nubians had *S. haematobium*, less than half that found by Rifaat and Nagaty (1958). Because of differences in methodology,

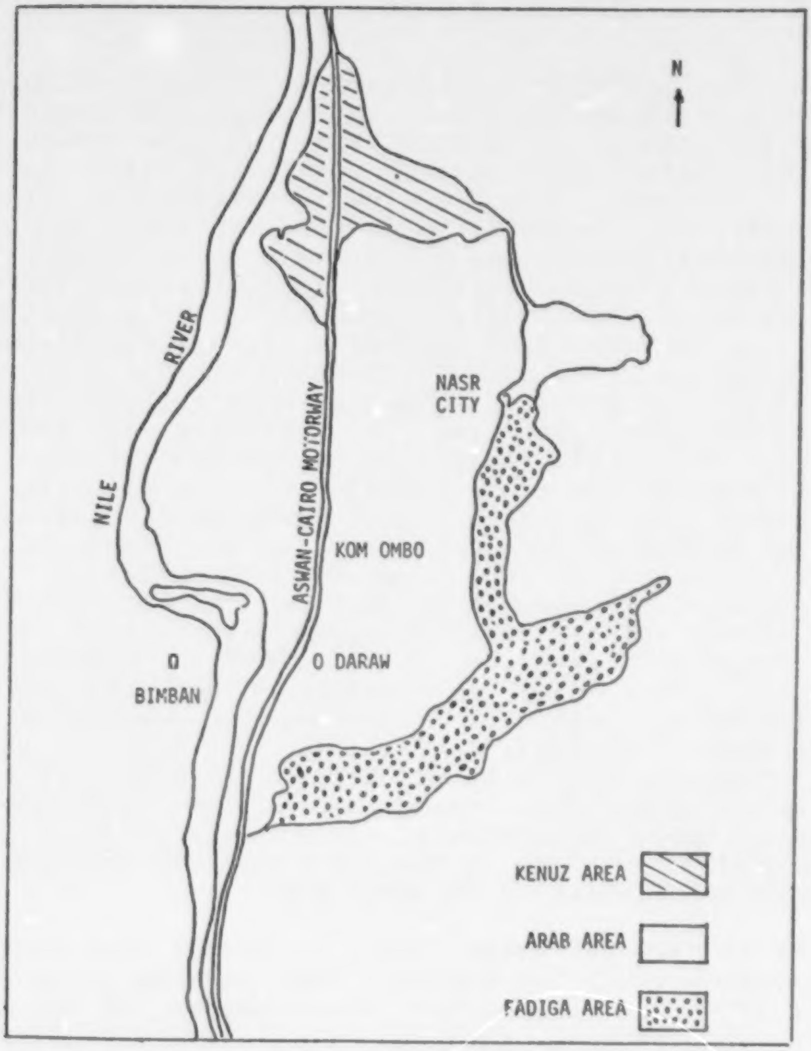

Figure 11. This is a map of the Kom Ombo area showing the resettlement pattern of the Nubian tribes.

Table 13

The Percent Prevalence of _S. haematobium_, 1958. After Rifaat and Nagaty, (1970)*

Village, Type of Irrigation, and Tribe	No. Persons Examined	No. Positive _S. haematobium_	Percent
El Dakkah Perennial Kanooze Tribe	132	47	36
Kurta Basin Kanooze Tribe	83	12	14
El Malki Basin Arab Tribe	104	67	63
Eineba Both Fadiga	87	11	12
Ballana Perennial Fadiga	82	56	68
Arminna Basin Kanooze	32	12	37
Total	520	205	39

*Caution should be taken when interpreting these findings. There is no evidence to show that the population selected was representative.

especially sampling protocols, it is quite impossible to compare the two surveys. However, the work of Zawahry (1964) lends itself easily to future studies or follow-up studies for purposes of comparison. Naturally, comparative studies require that laboratory and other data gathering methodology be consistent. This is only possible if details of the methodology employed are described as was the case in the report by Zawahry (1964).

All too frequently, reliable baseline data do not exist for populations in Africa and in other developing

Table 14

Age-Specific Prevalence of *S. haematobium*, Nubia, 1958. After M.A. Rifaat and H.F. Nagaty, (1970).

Age (years)	% Positive for *S. haematobium*	
0-4	---	
5-9	56.0	
10-14	30.0	Total Sample=1,387
15-19	43.0	Males=1,083
20-29	14.0	Females=304
30+	18.0	
ALL AGES	40.0	

areas where large man-made lakes have been built. Demonstrations of changes in health patterns arising from lake-making are difficult, if not impossible, when data are lacking prior to dam construction. Typically, impact statements on the effects on health of these water management schemes rely only on data collected following construction of dams. Zawahry's (1964) work makes it possible to assess accurately the Nubian population now that they have been resettled. Trends can be estimated, and the impact of the environmental changes resulting from displacement can be made.

Details of Zawahry's results have been reproduced in Tables 15, 16, and 17. Table 15 shows the age and sex of persons who gave urine or stool specimens by village and tribe. The total sample of 925 individuals, closely reflecting the demographic composition of the 1960 Nubian population were selected. Table 16 shows the age-sex specific prevalence for the sample. Typically higher levels of prevalence are seen in the younger groups. The prevalence by village, hamlet, and sex can be seen in Table 17. The dramatic difference in prevalence between Kurta and the other two villages reflects differences in irrigation practices. Snail surveys carried out by this study were unable to find vector snails along the Nile banks, although a total of some 44 km were surveyed and 1320 dips were made. Snails were found in 7% of the 600 dips made in canals where perennial irrigation projects had been established.

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Table 15
Distribution of Individuals Who Submitted Urine and/or Stool Specimens
by Age, Sex, and Locality (Tribe), Nubia, Egypt, U.A.R., 1963
After Zawahry (1964).

Age/Group	Sex	Village and Tribe							
		Kurta (Kanoose)		El Malki (Arab)		Ballana (Fadiga)		Total	
		Urine	Stool	Urine	Stool	Urine	Stool	Urine	Stool
0-5	M	19	12	15	12	7	8	41	32
	F	12	11	10	11	1	1	23	23
	T	31	23	25	23	8	9	64	55
5-14	M	43	41	28	27	47	43	118	111
	F	55	52	22	21	42	40	119	113
	T	98	93	50	48	89	83	237	224
15-44	M	5	4	23	20	40	39	68	63
	F	94	86	57	57	83	82	234	225
	T	99	90	80	77	123	121	302	288
45 +	M	20	16	14	13	23	22	57	53
	F	94	88	37	37	38	34	169	159
	T	114	106	51	50	61	56	226	212
All Ages	M	87	75	80	72	117	112	284	259
	F	256	237	126	126	164	157	545	520
	T	342	312	206	198	281	269	829	779

As mentioned, Dazo and Biles (1972) surveyed a sample of Nubian resettlement villages in 1972 in the Kom Ombo agricultural plain. If their estimate of 19% prevalence, which is not a great deal different from the 15.2% found by Zawahry, is true, then little change in schistosomiasis prevalence has resulted from relocation. These two surveys, however, lack comparable features in their methodology. Thus, any conclusions drawn must be taken with the utmost skepticism. Certainly no unequivocal epidemiological statements can be made.

It can be concluded that recent accurate estimates of *S. haematobium*, the only species present, in Old Nubia have been made, and the provisions of the methodology have been met providing grounds on which reliable assessments can be made in the future.

Schistosomiasis in Lake Nasser

In 1964, the coffer dam at the head of the diversion canal, just south of the new AHD, was dynamited. Water began to fill in behind the then yet uncompleted AHD. By 1970, the AHD was completed, and by 1975 Lake Nasser had, predictions outstanding, filled. All of Old Nubia was flooded, which included agricultural lands and a number of pharaonic sites.

WHO sent four missions to Lake Nasser in the period between 1970 and 1974. Satti (1970) estimated that there were 3307 fishermen working along the shores of the lake and examined about 14%, or 463 persons, for urinary schistosomiasis. Twenty-nine percent had infections, and 45% of a smaller group of fishermen examined at the Aswan Hospital had infections. Dazo and Biles (1971) surveyed fishermen along the entire length of the lake and found that 51% of 111 were infected. The only permanent population on the shore of Lake Nasser is at the Abu Simbel temple. The 134 persons there cannot be considered local indigenous inhabitants, but are rather Government employees coming from a variety of locations from all over Egypt. Nine percent had *S. haematobium* infections. The remaining shoreline of the lake was "a vista of barren rock and arid sand" (Dazo and Biles, 1971). In 1972, 23 out of 32 fishermen (72%) were demonstrated to have *S. haematobium* infections (Dazo and Biles, 1972). In 1974, Scott and Chu (1974), consultants for WHO, reviewed these findings and concluded that it was impossible to tell if infection was being acquired from the lake or from endemic areas of Upper Egypt during periods when fishermen were visiting their families. Each investigation included a malacological survey. Between 1970 and 1974, snails of the species *Bulinus truncatus*, the vector host for *S. haematobium*, were found throughout the

Table 16
Percent Prevalence of Bilharziasis by Age and Sex;
Nubia, Egypt, U.A.R., 1963. After Zawahry (1964).

Age Group	Males		Females		Both Sexes	
	Number Examined	% Positive	Number Examined	% Positive	Number Examined	% Positive
<5	41	2.4	23	0.0	64	1.6
5-14	118	31.4	119	20.2	237	25.7
15-44	68	33.8	234	15.3	302	19.5
>45	57	7.0	169	0.6	226	2.2
All Ages	284	22.9	545	11.2	829	15.2

Table 17
Percent Prevalence of Bilharziasis by
Locality (Tribe) and sex; Nubia, Egypt.
After Zawahry (1964).

Village (Tribe)	Males		Females		Both Sexes	
	Number Examined	Percent Positive	Number Examined	Percent Positive	Number Examined	Percent Positive
Kurta (Kanoose)	87	6.9	255	3.1	342	4.1
El Malki (Arab)	80	30.0	126	16.7	206	21.8
Ballana (Fadiga)	160	29.9	121	19.5	281	23.8
Total	327	22.9	502	11.2	829	15.2

lake in the south as well as the north and on both eastern and western shores. A large number of foci were observed. No infected snails were found except near the High Dam area of the lake.

In brief, Lake Nasser is populated by 3,000-5,000 transient fishermen and there are no permanent settlements located along the shore of the lake, except at Abu Simbel where there is a small group of government personnel stationed for maintenance and care of the temples (Dazo and Biles, 1971). There are vector snails present throughout the lake. There is an indication that a large number of the fishermen are infected with S. haematobium. Transmission in the lake may be limited to the area near the AHD.

Schistosomiasis in the Desert and Reclamation Sectors

The remaining settlements in Egypt are located along the western Mediterranean shore and at desert oases. In 1952, the population of the Dakhla Oasis had a schistosomiasis prevalence of 65% (Abdallah, 1973). Repeated molluscicciding had reduced this prevalence to 0.7% by 1957 (Nagaty and Rifaat, 1957). Rifaat et al., (1963) confirmed these again in 1963. Rifaat, et al, (1964) surveyed Wadi El Natrun, also a desert site, in 1964 and found only those that had recently come from the Nile Delta had schistosomiasis infections. Also in 1964, Rifaat (1964) looked at the western coast at Merso-Matruh and again found the area free of schistosomiasis.

Those areas of Egypt not watered by the Nile, i.e., the western coastal region and desert area, are apparently free of schistosomal infections either because of control programs or because of the lack of perennial irrigation schemes.

New reclaimed lands comprise important new areas into which the schistosome species have a high likelihood of being introduced because of the associated irrigation expansion. The area between Cairo and Assyut is an example of land reclamation that took place over 40 years ago. Reclamation in this discussion, however, will be reserved for those areas in which there was no previous indigenous population and, thus, must be settled with persons originating from elsewhere. An example of such an area is cited in the previously mentioned Egypt-49 project in the Beheira Province. Moreover, because of the new additional water resource, some $1X10^6$ feddans have been proposed for reclamation. It is interesting to note that while new lands have been reclaimed in the last 15 years, there has been a net loss of cultivated land in Egypt due primarily to urban sprawl, military construction, and road construction

(Waterbury, 1974). Also, after the outbreak of hostilities in 1967, reclamation activities were delayed.

Schistosomiasis in Egypt: A Summary

In Egypt, schistosomiasis, also known as bilharziasis, is caused by infection with either *S. haematobium* or *S. mansoni*, or both. Snails of the species *Bulinus truncatus* and *Biomphalaria alexandrina* are the respective vector host. Schistosomiasis in Egypt has been present since pharonic times. In the latter part of the last century and in the early part of this century, the Nile Delta was converted from basin irrigation to perennial irrigation, which brought with it widespread infection with both species of schistosomes and rendered the delta "hyperendemic". Recent studies in the delta show that schistosomiasis is still quite prevalent, although not as high as it had been earlier. Numerous control projects have been carried out, and it should be noted that mollusciciding, chemotherapy, environmental and educational programs have been, and continue to be, ongoing activities at the some 2140 rural health units and centers, in the secondary schools, and at the 162 endemic disease treatment centers. The relationship between perennial irrigation and schistosomiasis transmission has been repeatedly demonstrated. In addition, *S. mansoni* infection was found to have a limited geographical distribution restricted to the delta. Sporadic cases have been seen in Giza and in Beni Suef.

Before 1940, prevalence of *S. haematobium* was found to be high (60% or more) in the area south of Cairo and north of Assyut where perennial irrigation has been the predominant method of cultivation. This includes the Fayoum area. Recently, control programs have considerably reduced the prevalence of *S. haematobium* in this area. The data from 1955 strongly suggest that an overall drop in prevalence was occurring when compared to the 1937 studies.

From Assyut south to Aswan, only *S. haematobium* is found, and before 1940 *S. haematobium* prevalence was very low, except in the Kom Ombo plain (Scott, 1937). Surveys carried out between Aswan and Assyut in 1972 (Dazo and Biles, 1972) inconclusively suggest that there has been an increase in *S. haematobium* prevalence since the area has now been completely converted to perennial irrigation. Basin irrigation was no longer found after 1965 in Egypt (Dazo and Biles, 1972). Excellent historical data exists on the prevalence of schistosomiasis in the Nubian populations before resettlement in the Kom Ombo plain but no conclusive studies have been completed to assess changes following the Nubian resettlement. Clearly, these two areas are prime sites for assessing changing patterns of schistosomal infections. This does not mean that studies should not be carried out on the fishermen populations in Lake Nasser, or at reclamation sites. Indeed, surveys are currently being organized to follow schistosomiasis transmission in Lake Nasser by the EMH as a companion study to the WHO interregional project (IR 9658RAF/71/217) on schistosomiasis in Lake Volta, Ghana.

Irrigation Expansion and the Aswan High Dam

Since irrigation schemes are a critical factor in transmission and spread of schistosomiasis in Egypt and because irrigation schemes were to be expanded as the AHD complex was completed, it is important that all available information concerning the development and implementation of irrigation projects in Egypt be included as a part of this review.

To reiterate, both the reclamation of new lands (lands uncultivatable previous to the AHD because of limited water resources) and the conversion of basin irrigated land to perennially irrigated land were cited as projects which would result in the increase of schistosomiasis in the population. The areas of interest for reclamation have been in the eastern desert regions between the Nile Delta and the Suez Canal and west of the Nile Delta, south of Alexandria, where reclamation has been very active in the recent past. Since the 1930's virtually all land under basin irrigation has been located in Upper Egypt, and it is in this area that schemes for conversion to perennial irrigation have been focused.

The term "perennial irrigation" has been rather loosely applied, usually indicating simply the improvement over basin irrigation by installing pumps to raise water for cultivation rather than wait nine months for the next flood. In effect, basin irrigation in Upper Egypt was frequently being "supplemented" during the months without flood waters. A good example of this type of "perennial irrigation" was described by Khalil and Azim (1938) in their original work on the impact of irrigation schemes and the transmission of schistosomiasis in Upper Egypt. Another example was in old Nubia where pumps and canals had been installed at selected sites as pointed out earlier (Zawahry, 1964), and where schistosomiasis had increased. In villages where standard basin irrigation was continued, without pumps and canals, prevalence was low.

The type of pump used for these earlier "perennial" schemes was characteristically a large gasoline-driven pump housed on a floating platform (see Figure 12). These "floating pump houses", which are still commonly seen docked along the river banks of Upper Egypt, were designed to provide water to canals regardless of wide variations in the water level or discharge of the Nile typical of the era before construction of the AHD. Many of these pumps still function, but government-funded irrigation expansion has installed more modern electrically driven concrete-housed pumping complexes capable of lifting much greater volumes of water, thus increasing the potential for year-round cultivation. Irrigation engineers typically refer to these schemes as perennial or "permanent" irrigation, and irrigation practices previously used were vaguely described as basin irrigation. In a sense this is correct because land was flooded in Upper Egypt before the coffer dam was cleared in 1964 and the lake began to fill. Nevertheless, the floating pumps and their related canals and drains were also present. This has resulted in a degree of confusion as to what has been irrigated and how in Upper Egypt. The number of floating pumps, when they were installed, and the amount of land serviced is not known, as productive sources of information on the development of irrigation schemes of any kind are scarce. The data obtained from Egyptian governmental sources (EG, 1977) and translated from Arabic (see Tables 18 and 19) provide a limited amount of insight on the number of feddans converted to "permanent" irrigation in Upper Egypt. According to the data reproduced in Table 18, Aswan was completely converted to "permanent" irrigation during the period between 1933 and the present, and, by 1974, there were 92 thousand feddans yet to be irrigated by "permanent" methods in all of Upper-Middle and Upper Egypt. Table 19 is a more detailed break-down, by year, of when irrigation conversion by the governmental agencies was carried out. For example the 282 thousand feddans available for conversion in Qena governorate were irrigated by 1969. There was no change in the number of feddans converted in the Sohag governorate from 1965 to 1974, indicating that the irrigation projects were completed by 1965, except for 34 thousand feddans still to be converted. A total of 881 thousand feddans of Upper-Middle Egypt and Upper Egypt were converted to "permanent" irrigation in the 15 year period between 1959 and 1974, according to these government figures.

Note in Table 17 that the region proposed to be irrigated in 1959 in Sohag comprised 295 thousand feddans, virtually the entire area of this governorate. According to the information in Table 17, the government engineers apparently considered Sohag as an area under basin irrigation in 1959. However, the results of the 1955 schistosomiasis survey (EMPH, 1955) showed sharp increases in schistosomiasis prevalence indicating that at least some man-made irrigation schemes were already present. This increase occurred before the implementation of the large "permanent" government funded irrigation projects.

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Table 14
The Status of Irrigation Schemes in
Upper-Middle and Upper Egypt by Year.
After Shindy (1977).

Year	Aswan	Qena	Sohag	Assyut	Minya	Beni Suef	Total
	Governorate Number of Feddans (in Thousands)						
1933	65	ND¹	ND	ND	ND	ND	ND
Area Suggested by EMA² for "Permanent" Irrigation 1955	ND	282	295	266	86	44	973
Area Converted to "Permanent" Irrigation 1974	ND	282	261	266	71	1	881
"Permanent" in 1976	65	282	261	266	71	1	946
Currently Remaining Unconverted	0	0	34	0	15	43	92

¹ND No Data
²EMA Egyptian Ministry of Agriculture

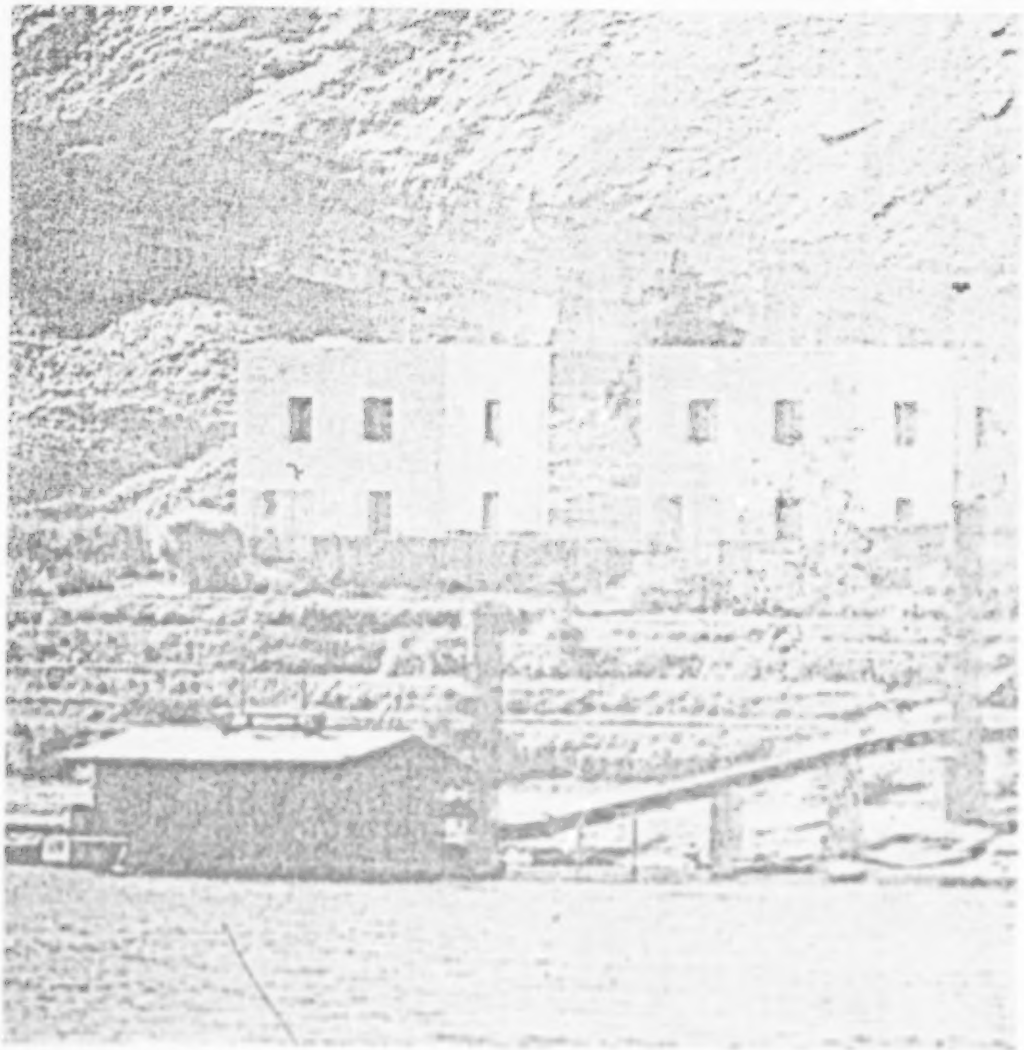

Figure 12. A "floating pump station" at Qena.

Table 19
Conversion to "Permanent" Irrigation by Year
in Selected Governorates
After Shindy (1977)

Year	Governorate Cumulative Number of Feddans Converted (in Thousands)				
	Qena	Sohag	Assyut	Minya	Beni Suef
Before 1965	282	295	266	86	44
1965	38	261	239	0	0
1966	50	261	239	0	0
1967	201	261	239	0	0
1968	282	261	239	0	0
1969	282	261	256	11	0
1970	282	261	266	44	0
1971	282	261	266	61	0
1972	282	261	266	64	1
1973	282	261	266	69	1
1974	282	261	266	71	1

Obviously, pumps, most likely the kind shown in Figure 12, and canals had been installed in many areas of Sohag during the late 1940's and early 1950's, but there are no data to confirm this. The question is, "Did Qena, after 1955, when schistosomiasis prevalence was still low (EMPH, 1955), expand irrigation systems, using the 'floating pump' system?" It is probable that, like the other areas of Upper Egypt, Qena's first irrigation expansion occurred before the AHD complex was begun. The "floating pump" structures can still be seen docked along the Nile banks of the Qena governorate, indicating that at some point in time these pumps were used for irrigation. Therefore, the possibility should be considered that schistosomiasis prevalence had increased or was increasing in the governorates of Upper Egypt, as a result of these earlier irrigation methods, before the implementation of the larger government irrigation schemes, and before the AHD was begun.

Waterbury (1974) has pooled information on land and water use in Egypt in an excellent review article. Table 20 from Waterbury's (1974) article shows the cropped area by season and year. Note the drop in number of feddans cropped in the autumn between 1952 and 1966. It was during this season that the Nile flooded. After 1964, cultivation could be increased during the productive summer months. Figure 13 graphically shows the interesting relationship between the growth of the population and agricultural expansion.

According to Waterbury (1974), more land was reclaimed before the AHD than after it. By 1973, 902,000 feddans had been reclaimed, of which about half were being cultivated. Many of the areas selected for reclamation were of marginal quality requiring great expenditure before cultivation was possible. Indeed, the agricultural area seems to be decreasing rather than increasing. Although 902,000 new feddans had been added, there was a net loss of 200,000 feddans by 1973 due to urban expansion, road building, factories and military installations.

Aside from the fact that land reclamation seems to be rather limited at this time, there is doubt that reclamation as such is a mechanism for causing an increase of schistosomiasis in Egypt. To illustrate this point, envisage an area, devoid of farms and settlements. With the increase in available water, the area is irrigated and developed into state farms. Families, most likely non-landowners, are brought in and settled. These resettled families and their members are now at risk of acquiring schistosomiasis, but were they not already at risk? Are not many of them already infected, having long since acquired the infection at village homes in the delta or in the south? It is doubtful that many of the families that move to reclaimed lands originate from urban settings. Thus, land reclamation imposes a risk of changing the geographic distribution of the disease, but is unlikely to cause an increase in the prevalence of schistosomiasis in the population. Changes in the distribution of schistosomiasis certainly complicates control, but increases in prevalence in the population have far greater implications.

Environmental Health Conditions in Egypt

The historical information sought for environmental health conditions in Egypt included the following:

1) General village sanitation

2) Rural water supply wastewater practices

3) Rural wastewater practices

Table 20
Aggregate Cropped Surface ('000 feddans)
After Waterbury (1971).

Agricultural Season	Year						
	1952	1966	1967	1968	1969	1970	1971 (Estimate)
Winter	4,364	4,739	4,776	4,929	4,849	4,835	4,871
Summer	3,026	4,794	4,857	4,945	5,050	5,053	5,012
Autumn	1,824	760	622	646	601	618	610
"Garden"	94	195	207	225	232	244	249
Total	9,308	10,488	10,462	10,745	10,732	10,750	10,742

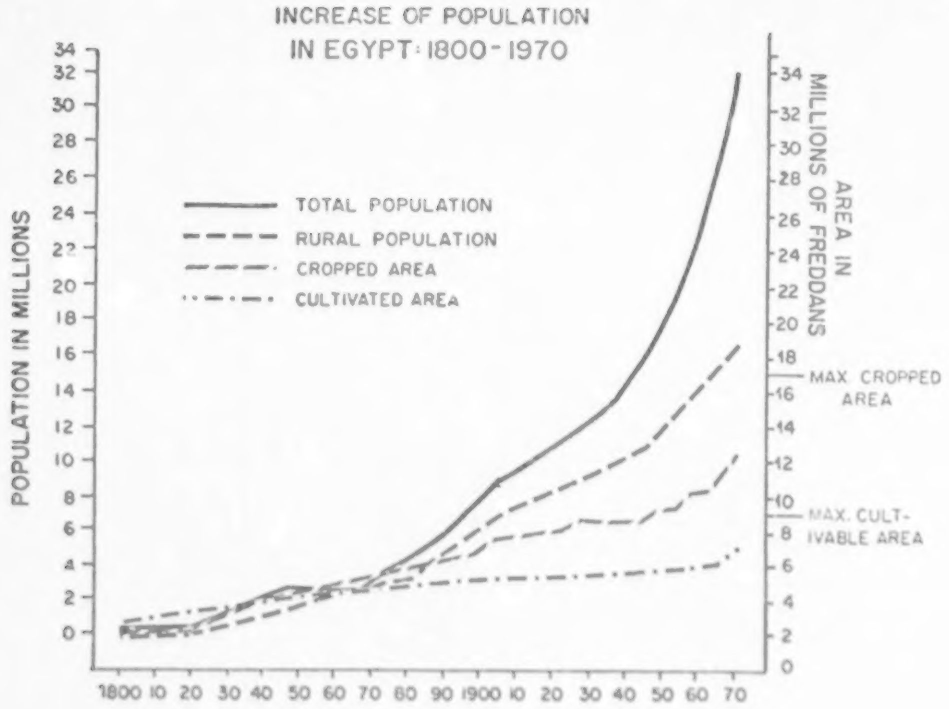

Figure 13. The relationship between population growth and agricultural expansion. The lines representing cultivated and cropped areas for 1970 are overestimates. After Waterbury (1974).

4) Rural housing conditions

5) Refuse or solid waste practices.

Detailed analytical information on these parameters is rather limited for Egypt as a whole. Several local studies are available however for the delta and for Old Nubia. Data from these studies have been provided in somewhat greater detail.

Amin and Zaghloul (1959) in 1959 reviewed the administrative organization of the EMH environmental services but provided little data. They did point out that by 1959 protected rural water supply had been provided to each village over 1,200 persons. Generally, water was pumped from an underground source to elevated tanks which supplied a limited number of public water standpipes (one or more taps fixed to a vertical concrete slab). This water supply project had been started in the 1940's and by 1960 fairly wide coverage was obtained. In 1975 all villages had at least one protected source of water. The goal of one standpipe per 300 persons was 90-95% completed by this time (Furnia, 1975). This is very impressive when compared with the water supplies available in the rural villages of other similar developing countries. Installation of latrines in the rural areas has been less successful (Furnia, 1975).

The major refuse problem in Egyptian villages is animal waste (Headlee, 1933; Weir, *et al.* (1952). Animal manure is still commonly used for composting and for cooking fuel. The compost heaps and the drying dung cakes cause a serious sanitation problem by providing ample sites for fly breeding. For the most part, solid waste in the conventional western sense does not exist in Egyptian rural villages. Only infrequent isolated litter piles may be noted in typical villages. However, where multistoried housing projects have been constructed and in urban areas there are extensive solid waste problems. On the village level very little solid non-organic material is discarded. This picture is now beginning to slowly change as the population grows and as more consumer goods become available to the rural populations.

Focusing on the delta, Headlee (1933), made detailed environmental observations on the rural village of Rushdy, Qalyubia. No clinical data were provided but excellent maps were made showing the defecation sites in the village. Samples were taken from these sites and examined for helminthic parasites. *Enterobius*, *Ascaris*, *Trichuris*, *Hymenolepis*, and *Ancylostoma* were detected in the samples. Defecation habits did not center around any favored site in the village area but were scattered throughout. This habit of "indiscriminate" defecation at many different locations,

locations which often provided little or no shelter, rather than at isolated places (for example, palm stands) was also observed by Scott (1937).

According to Scott (1937), this indiscriminate habit has important implications concerning hookworm transmission. If the same defecation sites were frequented then hookworm transmission would be favored. However, defecation sites were scattered and, as Scott (1937) showed, the prevalence of hookworm was not as high as might be expected.

Headlee (1933) also observed the still common practice of disposing household wastewater in the village streets and that the presence of a stable attached to the home contributed to the intense fly problem. Farooq, _et al._ (1966a) commented that village conditions in the delta had changed little since Headlee's report.

Weir, _et al._'s (1952) study (1952) of the same general area (Sindbis, Qalyubia) confirmed Headlee's observations. Weir _et al._ (1952) also found that 31% of all the homes in the study area had latrines out of a total of 4,878 houses examined, and 10% had wells. Flies in the study site were noted in large numbers. Counts were made monthly on the fly populations. These counts showed seasonal fluctuations with low numbers in the middle winter months and high counts for the remainder of the year. Measures were taken to reduce the fly populations, and it is interesting to note that during a two year period in the areas where control was maintained, infant mortality was markedly reduced. This is a very important observation. No other environmental measure tested during this study demonstrated any improvement in infant mortality, indicating the overwhelming importance of flies as vectors of serious infantile diseases.

In 1966, Farooq, _et al._ (1966a), found that 87.6% of the people in Beheria, in the north western delta, had piped water, a 77% increase in the number with piped water since 1952. The exact distribution of people with or without piped water is shown in Table 21. Ten and a half percent of the sample used canal water exclusively.

Table 22, reproduced from Farooq's study, shows the number and distribution of people by type of house. There were considerable differences between divisions with an overall 50.5% living in stone or redbrick houses and 40.3% living in mud or mud brick houses. Farooq, _et al._ (1966) also determined the number of persons with a cowshed and the number and distribution of latrines. They found that just over half of the population do not have cowsheds, 32.9% have adjoining cowsheds, and 14.4% have separated cowsheds. The latter group were considered to be in a higher economic class than the former two. At these study sites 52% of the

Table 21
Distribution of Examined
Population by Source of Water Supply.
After Farooq, *et al.* (1966).

Water Supply	Number of People	Percentage Distribution
Canal	1248	10.5
Piped Water	10466	87.6
Other	70	0.6
Not stated	160	1.3
Total	11944	100.0

population was found to have latrines; 10% had latrines and did not use them. (It would be interesting to know just how this was determined.) 36.4% did not have a latrine. This indicates that there is an increase in the number of latrines in the homes since Weir, *et al.*'s (1952) time.

Table 22
Distribution of Examined Population
by Type of Housing.
After Farooq *et al.* (1966a)

Type of House	Number of People	Percentage Distribution
Stone or Red Brick	6988	58.5
Mud brick or mud	4811	40.3
Other	7	0.0
Not Stated	138	1.5
Total	11944	100.0

As shown in the previous sections on schistosomiasis all the above environmental parameters influenced the transmission of infection, with the exception of latrines which showed a marginal decrease in prevalence, and only when age and type of house were controlled for.

In Upper-Middle Egypt only the report by Hassouma (1975) is available on a rural housing survey. Table 23 is reproduced from this report to the Egyptian Ministry of Planning. A majority of the houses obtained water from public standpipes (54%). However, a significant number (14%) had water piped to the home. For 12% of the homes, water came from the canals.

Table 23
Water and Waste-Water Facilities in Upper-Middle Egypt. After Hassouma (1975).

Type of Facility	Village					
	Faraskour		Oueaa		Deshna	
	#	%	#	%	#	%
Water Supply						
Piped Inside	36	13.6	4	1.6	48	35.8
Piped Outside	106	40.2	194	74.6	54	40.3
Hand Pump Inside	120	45.4	8	3.0	8	6.0
Canal	2	0.8	54	20.8	24	17.9
Waste-Water Disposal						
Sewer	34	6.5	4	0.8	44	16.7
Septic Tank	94	1.8	8	1.6	38	14.5
Latrine	134	25.5	219	36.9	46	17.6
None	264	50.2	260	531	134	51.1

Hassouma (1975) also found that 6.4% of the houses were converted to sewage systems and that 10% had septic tanks. These fascinating observations, especially the presence of the sewage systems, beg the question "what did the author use as a definition of 'rural'?" Unfortunately, no answer was provided. However, over half of the houses surveyed did not have a latrine.

Upper Egypt: in the area between Assyut and Aswan, only sketchy information exists and most of what does is centered on the Aswan environment only. In 1965 Aswan City had no sewage system and the large fertilizer plant (The Kima Company) nearby was inadequately treating its wastewater which was being discharged into the Nile (Messina, 1970). Others (Bachmann, 1965; Satti, 1970) reporting to the WHO found the Aswan urban area poorly developed in respect to wastewater management.

Old Nubia: In 1960 Abdady and Shalash (1966) from the National Research Center, Cairo, completed a one-year survey on the Nubians which examined the environment and livestock resources. Selection of families was based on the family register at each village and selections were representative and proportional to the 1960 census. It was a well-designed study. Each tribe was represented and Table 24 shows the number of families selected, by tribe, village, and the location of the village on the eastern or western bank of the Nile. Table 25 shows the housing conditions for each area. Table 26 shows the type of water supply, lighting and food storage in the house. Whereas this table points out that no sewage system existed, the general description of the text stated that toilets were located inside the houses in the Fediga area, and outside for the other two tribes. No numbers were provided on how many were available. Also included in this discussion was that the hand pumpwells located in the Fadiga area usually did not function.

Table 24
Tribe, Location, Village, and Number
of Families Selected in Nubia, 1960
After Abdady and Shalosh (1966)

Tribe	Location on Nile Bank	Village	Number of Families Selected
Fadiga	West	Ballana	275
Fadiga	East	Abu Simbe.	173
Arab	West	As-Sabu'a	75
Arab	East	As-Sangari	75
Kanoose	West	Sarf-Hussein	75
Kanoose	East	Kask Tamma	75

In the following villages, irrigation pumps and canals had been installed:

a) Dikka

Table 25
Housing Characteristics, Old Nubia, 1960.
After Abdady and Shalash (1966).

Tribe	House Characteristic							
	Area in m²		Building Material				Number of Rooms	
	Total	Mean	Mud	Mud Rock	Wood Cane	Mud Cane	Total	Mean
Fadiga	234860	528	428	0	16	1	2658	5.9
Arab	53170	355	0	150	0	0	801	5.3
Kanoose	34550	230	0	150	0	0	627	4.8

Table 26
Water Supply and Lighting in Old Nubia, 1960. After Abdady and Shalash (1966).

Tribe	Water Source			Lighting	
	Small Canals	Nile	Pump	Electric	Kerosene
Fadiga	94	275	76	0	445
Arab	0	93	57	0	150
Kanoose	0	10	140	0	150

b) Al-Alaqi
c) Aniba
d) Tushka
e) Aramna
f) Abu Simbel
g) Ballana

A description of the village areas was included in the report. In the Fadiga tribal areas, houses were in rows with 20-30 meters from one row to the next, spreading out over a 500 by 600 meter area. Houses made of combinations of mud, rock, and cane were architecturally similar to the American Indian hogan with walls extending out to encompass a courtyard, a guest room, and a stable. A characteristic feature of Nubian houses is the decoration of the walls, both on the inside and outside. There is a prevailing attitude throughout Egypt that the Nubians are exceptionally tidy and honest.

Floor plans of the old Nubian houses have been prepared by Fernea (1973).

In brief, Egypt has had a progressive plan for the provision of a protected water supply to the rural areas since the 1940's. A visit to the rural areas readily confirms the widespread distribution of rural water supply. This project has probably reduced the numbers of persons visiting canals or unprotected water courses for their water, but still evident in the rural areas are the women washing clothes and dishes in the canals, the children bathing in the canals, and the farmer irrigating his fields by ancient methods requiring contact with canal water. Generally the sanitation conditions in the villages of Egypt have improved somewhat since Headlee's study (1933). In terms of crowding, they may have become worse.

CHAPTER III

MATERIALS AND METHODS

This study is separated into two major subdivisions. The first, termed the "downstream study" is a comparison of environmental and epidemiological health parameters at different village sites comprised of indigenous rural populations located downstream from the AHD, excluding the relocated Nubians. The second, termed the "Nubian study" is concerned with the Nubian populations displaced by the formation of Lake Nasser. The results of both investigations have been analyzed for correlations with environmental and epidemiological alterations resulting from the construction of the AHD. In both studies, the research is guided by an operational hypothesis.

Description of the "Downstream Study"

The downstream study is designed to assess the impact of the formation of lake nasser on indigenous rural populations in Egypt downstream from the AHD. The design rationale is based on a comparative approach for which data are collected from more than one site. Thus it can be determined whether changes occurring overtime or in a given location are unique, and causal relationships can be developed accordingly.

Three areas have been selected which afford maximum comparability. The first, from an area likely to be affected by Lake Nasser, are the rural villages north of the city of Aswan and south of Kom Ombo. The two other areas are Beni Suef, between the delta and Assyut, and Kafr El Sheikh, in the north central Nile Delta. For the sake of convenience, the three "areas" in which rural villages were selected for the downstream study are referred to as the Aswan, Beni Suef, or Kafr El Sheikh study area.

In each of these three governorates, rural villages have been selected based on: a) how representative the village is of the area; b) accessibility; c) population composition and size; d) the presence or absence of a rural health center or unit. The selection of villages from these three areas was also based on information obtained from past studies. It was clear from these studies that Upper-Middle and Upper Egypt had frequently been excluded, with a far greater number of past surveys being carried out in the delta. Within the delta, more prevalence information on schistosomiasis was available for Qalyubia than all the other delta governorates combined. Sites in Kafr El Sheikh were selected, therefore, to help correct this deficiency of information. Also, historical data indicated that the northern delta, in which Kafr El Sheikh is located, had maintained the highest schistosome prevalence in rural Egypt. The data from Kafr El Sheikh provided the ultimate baseline prevalence for this study, as opposed to areas farther south and geographically, more central. Villages were selected in the Beni Suef area as representative of Upper-Middle Egypt, for the simple reason that recent data indicated that the distribution of S. mansoni infections were slowly migrating south, from the Nile Delta into this area (Hussein, 1972, Alamy and Cline, 1977). Sporadic cases of S. mansoni had been seen in Beni Suef by Hussein (1972). It was therefore important to determine if S. mansoni cases could still be found or were increasing.

Description of the "Nubian Study"

This study is designed to measure the changes in the prevalence of schistosomiasis in the Nubian population following displacement due to the formation of Lake Nasser. The Egyptian Nubians, a population of 45-50,000 persons, resided in villages scattered along the banks of the Nile, south of Aswan to the Egyptian border. This population was displaced by the rising waters of the new lake in 1964. The Nubians, who were rural in nature and composed of three different tribes were moved en masse to Kom Ombo, 40 kms downstream from the AHD. For all practical purposes, the entire population was resettled in this area. The new villages bear the same names as those from which the settlers originally came and, in addition, retain their respective locations as in old Nubia with the Kanoose tribe in the north, the Arab in the middle, and the Fediga in the south (See previous Figure 11). No other formal arrangement was made by the government to have resettlements in other areas. However, there remains an original Nubian community located on the eastern Nile bank, just north of the old Aswan dam, called Kazan Sharq. This is the southernmost village in Egypt with the exception of a very small village located on an island in the reservoir that inundates the area between the old and new dams. No resettlement sites are present on the lake shore. The high ground surrounding the lake is harsh, barren, and, according to Dazo and Biles's (1971) survey, uninhabited, with the exception of the Abu Simbel community 300 kms upstream from the AHD.

Although Abu Simbel does not constitute a rural/agricultural community, it is the only permanent lake shore site currently inhabited. In 1971, the population of Abu Simbel was 134 and was comprised mostly of government workers employed in the maintenance of the Abu Simbel temples. Abu Simbel does not represent displaced Nubian communities, but is the only location that could possibly give an indication of the current health conditions at the lake shore. Observations made during a five-day trip on Lake Nasser in May, 1977 confirmed these findings. Earlier in the Review of Literature, Dazo and Biles (1972) found that 9% of the population there had S. haematobium infections. No other helminthic infections were observed.

The Nubian study includes three major sites between which comparative studies have been made: a) the old, no longer existing Nubian villages of Kurta, El Malki, and Ballana; b) the correspondingly resettled sites at Kom Ombo; and c) the original Nubian community, Kazan Sharq, located on the eastern Nile bank just north of the old Aswan Dam.

Abu Simbel had to be excluded because it does not represent the Nubian population. Also excluded are the lake shore sites which are yet to be developed, and the Lake Nasser fishermen. As mentioned previously, a joint WHO-EMH inter-region project (IR-065 RDF/71/217) is currently being organized to investigate the health status of the Lake Nasser fisherman population.

Hypotheses

The working hypotheses from which the survey design has been developed are:

1) The Downstream Study; There are significant increases in the estimated prevalence of schistosomiasis due to the construction of the Aswan High Dam and related irrigation expansion in the sample of the selected sites located in the Nile Delta, Upper-Middle, and Upper Egypt.

2) The Nubian Study; There are significant increases in the estimated prevalence of schistosomiasis due to the construction of the AHD and related irrigation expansion in the sample of the selected sites located in the resettled Nubians in Kom Ombo.

Definitions for pre- and post- AHD are needed to establish the point in time for describing 'before' and 'after' conditions necessary for making comparisons between studies. Pre-dam is defined as the period before the discharge of the Nile was controlled by the AHD. Post-dam is defined as the period from 1964 to the date of this study (1976). The construction of the AHD was not completed until 1974, but as mentioned earlier, the coffer dam, constructed to divert the flow of the river around the area where the AHD's foundations were being laid, was removed in 1964 and the ensuing floods have since been trapped behind the AHD. The reservoir reached maximum volume in 1976. The term "significant" is defined as a meaningful increase in the prevalence of schistosomiasis when comparing the results from different study sites used in this research with results from other villages employed by other workers. Frequently, the number of cases is large enough to demonstrate statistical significance between results differing only in one or two percentage points. Whereas this would constitute statistical significance, it would not be meaningful. Faroog, _et al._, 1966, and others (Bell, _et al._, 1967, Gilles, _et al._, 1973) have shown that on the average, the variation in prevalence of schistosomiasis from one Egyptian village to another is about 10 to 12 percentage points. This is a considerable amount of variation and is due principly to the focal nature of schistosomiasis distribution which has been consistently demonstrated since the earlier studies. Therefore, a significant or meaningful increase (or decrease) would require at least a difference of 10 percentage points.

Data Acquisition

The two major categories of data collected were: historical baseline data and data collected from field studies that included environmental health data and epidemiological morbidity data for schistosomiasis. The implementation of the field survey was guided by a program evaluation review technique (PERT) diagram.

The PERT diagram identified and numbered each individual activity or job to be carried out. The time in days required to complete each job was estimated and then each job was placed appropriately in the sequence. Except for the first, each preceding job or jobs had to be completed before the following one could be started. Thus, projected dates of completion were calculated. Moreover, free slack, or the amount of time that a previous job could be postponed without delaying the overall projected completion time, was estimated. The estimated time to complete the field activities up to the point of analysis of the data were 256 days. The actual time for completion was approximately 260 days.

Specific Data Collected

The categories for data which were collected are:

1) environmental health parameters:
   a) water supply and use
   b) sewage disposal
   c) housing
   d) irrigation practices
2) epidemiological parameters:
   a) age-sex structure of the sample population
   b) schistosomiasis prevalence.

It may be noted that agricultural irrigation methods have been included as an environmental health parameter. Generally, irrigation schemes, as such, do not fall within the realm of environmental health specialties. However, in Egypt as in a number of other tropical developing nations, agriculture practices and especially irrigation methods play a central role in the transmission of schistosomiasis. Moreover, it is the open canals and drains which are associated with present-day irrigation in Egypt that provide excellent habitats for snail vectors. For the rural populations of Egypt, canals long ago became a way of life. The convenience the canals have provided in the rural villages for domestic water for washing, bathing, swimming, drinking, and ablutions is readily evident to the visitor.

Data acquisition forms (questionnaires) were designed and translated into Arabic. These forms serve as a list for the various parameters under study. The original English data forms are included in Appendix 2.

The environmental health parameters are a critical measure under study. However, the environmental parameters not directly associated with water use require some explanation, e.g. housing. Housing is an important indicator of the level of sanitation, which is an important variable in this study. The level of housing conditions also serves as an indication of environmental changes in the resettled areas in the Nubian study.

Considerable peripheral data are included in the survey listed on the data forms. As much data as possible were obtained concerning all the environmental parameters in the hope that nothing would be overlooked simply because it was not requested. Secondly, data were needed to control for certain variables; for example age, sex, occupation, etc. Indeed, the study was originally designed under a much broader scope specified by the needs of the River Nile-Lake Nasser study of which this work was a part.

Selection of Field Survey Sites

A total of ten health units and centers were selected in Kafr El Sheikh and in Beni Suef based on criteria mentioned in the description of the downstream study. The name of the health unit or center does not always correspond to the name of the village from which the sample population was selected. Sometimes more than one village was sampled by the health unit or center. This is true also for Aswan and for the Nubian sites.

In Kafr El Sheikh the selected health units or centers, also termed "study sites", and their code numbers were:

(a) health unit El Agazein (16): only the village El Agazein was sampled;

(b) health center El Hamra (17): only the village El Hamra was sampled;

(c) health unit Mahalet El Kasab (18): only the village Mahalet El Kasab was sampled;

(d) health unit Mahalet Mousa (19): Mahalet Mousa and El Nataf were sampled;

(e) health unit Sheno (20): two villages, Sheno and Reskit El Shenawi, were sampled.

In Beni Suef, the selected health units or centers and their code numbers were:

(a) health center Barout (11): only the village Barout was sampled;

(b) health unit Sherif Pasha (12): only the village Sherif Pasha was sampled;

(c) health unit Naiim (13): two villages, El Amrana and Abu Mousa were sampled;

(d) health center Beni Adi (14): only the village of Beni Adi was sampled.

(e) health center Ashamant (15): only the village of

Ashamant was sampled.

Both Kafr El Sheikh and Beni Suef are the respective capitals of their governorates. Kafr El Sheikh is about 2.5 hours' drive north of Cairo, roughly 140 kms, and is located in the central northern sector of the delta. The northern border of the Kafr El Sheikh province is the Mediterranean sea. Almost the same distance to the south of Cairo is Beni Suef. To the north of Beni Suef is Giza; to the west, the Fayoum; and to the south, Minya. Each of the villages selected in both Kafr El Sheikh and Beni Suef was an agricultural community typical of the area.

In Aswan the selected health units or centers and their code numbers were:

(a) health unit Kazan Sharg (1): the village of Kakhor was sampled;

(b) health unit Guzaria (2): the villages Gamma, Omrob, and Harrob were sampled;

(c) health center Abu Rish Bahri (3): the villages of Mal Katta and Mal Licta were sampled;

(d) health unit Ga'afra (4): the villages of El Aratag, Shouna, Masagien, Falaleha, Omarab, Ali Abu Karime, El Sheikh Garat, Hedadoun, Hagar, and Mahatta were all sampled;

(e) health center Bimban (10): the villages of Kenisa, Abu Sharl, Omda, Mariab, Sheikh Mousa, and Kabarra were all sampled.

In the Nubian resettlement area of Kom Ombo, the selected health units or centers and their code numbers were:

(a) health center Ballana (5): the villages of Ballana 1,2, and 3 were sampled:

(b) health unit Tushka (6): only the village Tushka was sampled;

(c) health center El Malki (7): only the village of El Maiki was sampled;

(d) health unit Kurta (8): only the village Kurta 2 was sampled;

(e) health center Kalabsha (9): the villages Kalabsha and Abu Khor were sampled.

The location of the different selected sites in the

Aswan study area can be seen on the sketched map given in Figure 14. The village of Kazan Sharq (1) is one of the most southern villages to be found in Egypt. This village is comprised of Nubians of the Kanoose tribe, and it should be pointed out that Kazan Sharq (1) and a few remaining villages just to the north, are also populated by Nubians who, because of their location downstream from the AHD, did not have to be moved when Lake Nasser began to fill. Rather, this small population of Nubians are living in the same villages and the same homes that they were living in before the AHD was built, or, for that matter, from the last century and before.

The villages located at health units and centers 2,3, and 4 are communities typical of the area between Aswan and the Kom Ombo plain and are located on the eastern bank of the Nile. These communities are characteristically found on high, dry, barren ground. Because the Nile Valley is so narrow in this area, very little land is available for cultivation, and, therefore, what is available is far too valuable to build on. The cultivated areas are always found as a green strip between the village and the river, with the exception of Hagar in Ga'afra, which is located on a low barren hill next to the river. In this respect these villages are unlike the ones in the Kom Ombo agricultural plain. From the northern point of the Kom Ombo plain, continuing north, the narrow valley gradually begins to widen as it passes through the next two governorates, Qena and Sohag. In these sites the villagers live at a greater distance from the irrigation canals and drains than villagers located in the delta or in Upper-Middle Egypt. Villages are found within the cropped area with increasing frequency as one travels north and east of Aswan into Qena and Sohag. North of Sohag only a small fraction of the rural population resides in villages located outside the cultivated land, and these villages are often bounded on one side by their fields. The health center Bimban (10), was selected to represent villages typically built within the cultivated area. Six different villages all located in Bimban _markaz_ (center) were sampled. The Bimban _markaz_, seen on the map in Figure 11, is located on the western bank of the Nile Valley almost directly west of Daraw. The villages are separated from the Nile and from the desert to the west by fields of sugar cane and wheat, and by palm groves, etc.

The selection of the Nubian resettlement villages was based on the previous study by Zawahry (1964). Each village that was surveyed in 1964 has now been surveyed again for this study. They are Ballana (Fadiga) (5), El Malki (Arab) (7), and Kurta (Kanoose) (8). In addition two other villages were selected: Tushka (Fadiga) (6) and Kalabsha (Kanoose) (9), to increase the overall sample size.

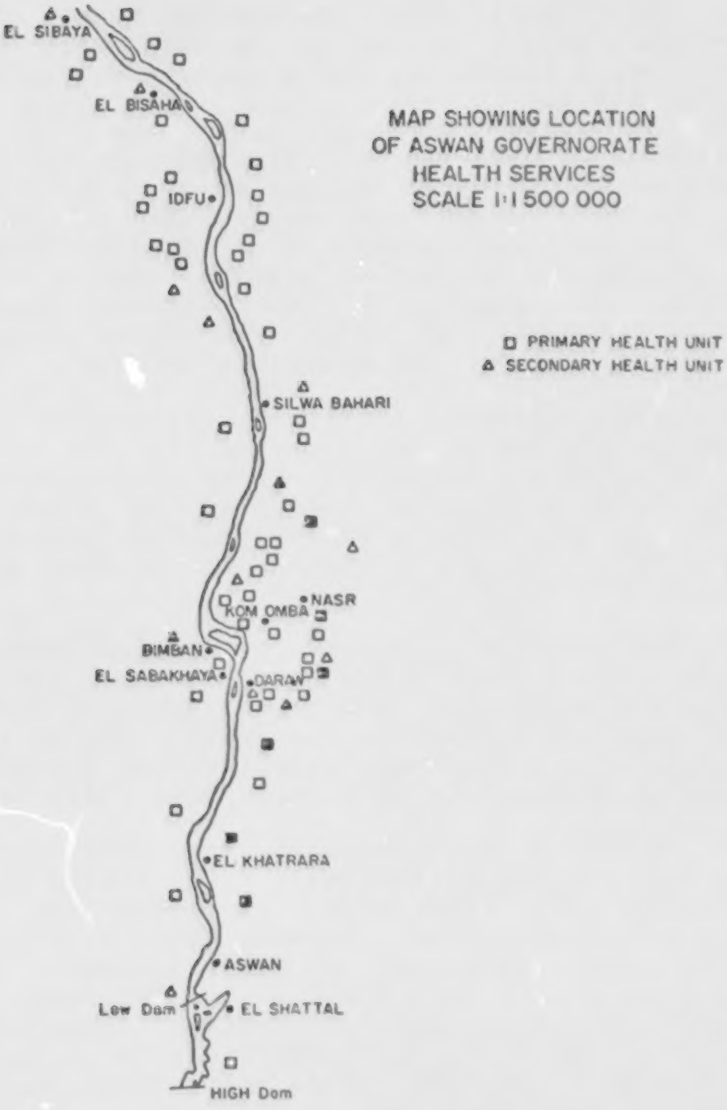

Figure 14. This is a sketch map of the Kom Ombo area showing the distribution of health units and centers. Also shown are the study site locations for this area, which are represented by the shaded units.

Data Collection Teams

The primary data collection teams at each of the selected health units or centers were comprised of a physician, a laboratory technician, a sanitarian, one or two nurses, and one or more aides. The team was led by the physician whose responsibility was to implement the collection of data and to ensure that all activities were completed according to the outlined procedures (see Appendix 4). The cooperation and employment of the various health teams was obtained through the Egyptian Minister of Health and through the respective regional offices of the director-general of health. The director-general provided transportation to the sites and local security approvals, and saw to it that the materials necessary to continue were received at the study sites. In addition, a field supervisor, typically a vice-director-general, was assigned to follow the day-to-day progress in the field and to work closely with the technical field supervisor (the writer). Aside from developing the plan of operation, acquiring materials, and training personnel, the role of the technical field supervisor was to coordinate the work at all levels at each of the twenty field sites.

The Egyptian Minister of Health assigned Dr. Baha Hashen, the director-general of all rural health services as a team representative from the ministry to the project. The EMH's services proved to be very helpful in establishing communications, transporting materials, collecting data, and obtaining cooperation of primary data collection teams.

The chief administrative team leader, Dr. M. Hussein, Dean of the High Institute of Public Health at the University of Alexandria developed the administrative structure by which the various data teams and members were employed and paid, and closely followed the day to day developments in the field. In addition, Dr. Hussein obtained the necessary governorate approvals and security permits and provided the laboratory space and personnel for the analysis of the stool and urine specimens at the University of Alexandria.

Review of Facilities and Preparation of Material

The location for the examination of families was a rural health unit or a rural health center. Each health unit (for outpatients only) and each health center (small scale in-patient facilities available) selected was assessed for facilities needed for the survey. If facilities or equipment were lacking, they were obtained by the local field supervisor from the respective director-general's office. For the most part these services were not needed as the health units and centers selected all had the required facilities and were in working order. These facilities included:

(a) a light microscope, monocular model, with at least low power (16mm focal length) and high power (4mm focal length) objectives, and related equipment - slides, etc. Often these were manufactured in Czechoslovakia and were similar to Japanese Nikon models.

(b) glass pipettes in sufficient quantity

(c) 250 cc glass conical flasks for urine sedimentation

(d) stool pans for the collection of stool specimens

(e) a hand centrifuge

(f) a balance for determination of weight and height

The balances were made by Detecto Scales, Brooklyn, N.Y., U.S.A.; model Detecto-medic or similar. Microscopes, balances and hand centrifuges were placed in the health units and centers by UNICEF about 5 years previously in a program to update rural medical facilities in Egypt.

The additional materials needed by the health units or centers for the recording of data and preparation of specimens were:

(1) printed data forms in Arabic

(2) solution for preservation of stool and urine specimens

(3) 10 cc plastic specimen vials or bottles

(4) disposable applicator sticks for transferring stool specimens

(5) permanent felt-tipped ink pens to label specimen bottles

(6) a reference or methods guide for the correct procedure to be followed during the survey

Printed data forms: the data forms for the clinical examination of the family, form code 01; and the data form for the examination of the house, form code 02; were first translated into Arabic at the High Institute of Public Health. The same procedure was used for the environmental forms coded 03 through 12. (All data forms and the methods guide are included in Appendix 2 and Appendix 3, respectively.) The translated forms were reproduced by mimeograph. At the beginning of the field activities all forms were reproduced at the High Institute of Public Health. Over 8,000 forms of 01 and 02 were necessary. Form 01 had three pages and 02 had four. Therefore, 56,000 sheets of paper were required just for these two forms. It soon became obvious that delays would develop if the forms continued to be mimeographed at the High Institute. Paper, stencils, and staplers were purchased and delivered to the local director-generals' offices, which took over the responsibility of providing printed forms.

Data form design: the data forms for the examination of the family were based in part on the studies by Farooq and Nielsen (1966), Zawahry (1963), and Hussein (1972). At each health unit a guide for the correct completion of the data form from the examination of the family was provided. This guide also included the correct method by which all procedures were to be carried out for the collection of field data. The guide served only as a reference and was not a substitute for instruction.

It should be pointed out, however, that special procedures were taken to determine age. The determination of age in a highly illiterate population is prone to error. Measures to minimize errors were adapted from Scott (1937). Scott (1937) found that it was more accurate to place a person in an age-group than to estimate the person's exact age. An age group sheet of 5-year age groups (starting from 0-1) was distributed with the methods guide and instruction for use was given to the physician. Birth dates were recorded only when government identification cards could be provided.

An attempt was also made to determine what medication, if any, the individual had taken in the 360 day period prior to the day of examination. Only medications for parasitic diseases were recorded. Other medication received was recorded as "other". Details for the methods of obtaining the remaining data and data for the housing are described in the methods guide.

The design for the housing form code number 02 was adapted from Mitwally and Sharqawi's (1970) article on measuring housing conditions in the rural areas of Egypt. For each data form a clear plastic overlay sheet with an English translation was made. These clear overlays provided an instant translation of the Arabic data form into English. As a guideline, the house to be examined by the sanitarian was defined as "the area lived in by the selected family".

Preservation of Stool and Urine Specimens

It was clear from the beginning that there was considerable variation in ability to examine stool specimens for parasites and ova between laboratory technicians at the selected health units and centers. To compensate for the undesirable variability and to maximize the comparability from one study site to another all stool specimens were preserved and sent to the laboratory at the High Institute. At the "central laboratory" the specimens were examined by a staff of trained personnel.

To implement this central approach for the examination of the specimens, a 10 ml translucent polyethylene bottle was provided for each individual at the selected sites. These bottles were purchased in Cairo and were 2 cm in diameter, 5 cm tall with a 1 cm opening in the top for which there was an inner cap and an outer screw cap,all polyethylene. On each bottle the code number of the individual, comprised of the health unit number, the family code number, and the individual's number within the family and his or her name were written with black, permanent, felt-tipped pens. Both pens and bottles performed well over the period of the survey. There was no occasion when the label came off, and the bottles, which were unbreakable, did not leak even though an occasional screw top had been deformed during the molding process.

The procedure for collecting the stool and urine for preservation is outlined in the methods guide. Two points should be added. One, that the urine specimens were examined at the health units by the laboratory technicians. In addition, two drops of urine sediment was added to the stool specimen for preservation and examination later at the central laboratory. In this way a double check was provided on the examination of urine. The results of the on site examination were recorded on the data form for the examination of the family, form 01. Two, the transfer of the stool from the stool pan to the specimen bottle and the mixing of the stool with the preservative solution required something cheap and disposable. Broom straws, along with matchsticks and toothpicks, were all tested unsuccessfully. Very common in Egypt are small vegetable crates made by hand from palm fronds. The ribs of these crates were found to split nicely into straight wooden sticks which easily transferred and mixed the specimens. For preservation, the stool was mixed with 9.0 to 9.5 cc of merthiolate-formalin solution adapted from the merthiolate-iodine-formalin concentration technique (MIFC) (Blagg, et al., 1955). Ova, cysts, and trophozoites in fresh stool specimens collected in the MIF solution have been successfully preserved without deterioration of descriptive cytological features for a number of years. The exact period before deterioration begins is under study at the Naval American Medical Research Unit (NAMRU-3) in Cairo where the technique was first developed. Instead of adding iodine (Lugol's iodine) at the time of preparation when the specimen was mixed, as prescribed by this technique, the Lugol's iodine was added afterwards at the central laboratory just before the ether extraction phase. This alteration in technique, in addition to the fact that approximately 0.05 ml of urine sediment was being added, did not interfere with the desired staining intensity. By delaying the addition of Lugol's iodine at the health unit or center, the amount of materials that had to be delivered was reduced. This also assured that the Lugol's solution used was fresh, as it begins to deteriorate as a stain after one week. Thus the urine was examined twice, once at the health unit or center and once at the central laboratory.

Examination of Stool and Urine Specimens

All specimens were collected from each of the study sites and transported to the parasitology laboratory at the High Institute of Public Health. At the laboratory, a team comprised of nine physicians examined the specimens. The team was supervised by three senior lecturers of parasitology at the High Institute.

All specimens received at the laboratory from a particular health unit or center were grouped together. There was no intended order within the group and a few specimens at a time were selected for examination from each group. This quasi-random method helped minimize the biasing effect of individual ability among the laboratory personnel.

The preparation of a specimen for examination was as follows:

1) the specimen was mixed and poured through a layer of wet gauze into a labelled centrifuge tube.

2) 0.6 ml of fresh Lugol's iodine was added to the specimen.

3) 4 ml of petroleum ether added in order to increase the specific gravity of the ova and cyst by extracting the lipid fraction. The tube was inverted and shaken vigorously.

4) the specimen was centrifuged for 5 minutes at 1500 rpm.

5) the top ether layer and fecal plug, and MIF layer were removed by suction, leaving the sediment and about 0.1 ml of MIF solution on top of the sediment.

6) the sediment was resuspended and a drop of this mixture placed on a microscope slide, and covered with a cover slip.

7) the slide was examined for characteristic ova, cysts, and trophozoites.

8) results were entered on a coded specimen examination form, an example of which is shown below.

Stool examination form (Code 5)

Specimen vial number

Date

Helminths

Ascaris lumbricoides	1
Trichuris trichiura	2
Enterobius vermicularis	3
Ancylostoma duodenale	4
Strongyloides stercoralis	5
Taenia sp.	6
Trichostrongylus sp.	7
H. nana	8
H. heterophyes	9
F. hepatica	10
F. gigantica	11
S. haematobium	12
S. mansoni	13

Protozoans

Giardia lamblia	14
E. histolytica	15
E. coli	16
E. hartmanni	17
Iodamoeba butschlii	18
Endolimax nana	19
Chilomastix mesnili	20
Trichomonas hominis	21
Dientamoeba fragilis	22

Examined by.................................

The coded specimen form includes a place for the code numbers, date, form code, and code number of the examiner at the laboratory who examined the slide and places for indicating the presence of the various parasites screened. Only one slide for each specimen was examined.

An in-laboratory test was used to obtain data on individual examiner error. One specimen each day was examined by all members and the results scored independently. It was requested that the personnel examine the "test" slide in the same fashion as all other slides. The exam results were not shown to the personnel, and it was emphasized that this was a procedure to estimate error rather than a proficiency examination. All laboratory personnel at the High Institute were closely followed and exhibited proficiency in the identification of the various parasites. The helminth ova are easy to identify as they are generally large, and very characteristic in morphology. Proficiency was assured by comparing sample specimens with the NAMRU-3 laboratory.

An examination of the urine specimens for schistosome ova was also completed at the health unit or center's laboratory. The method used was the simple and classic sedimentation technique. This is the same method most commonly used in screening procedures where large numbers of specimens have to be examined and is described by Farooq and Nielsen (1966). Briefly, urine is placed in a 300 ml conical flask and left undisturbed for 30 minutes. The sediment is then transferred to a slide, covered, and scanned for ova under low power. This technique has been used in Egypt for a long time. None of the laboratory technicians at the health units or centers had to be retrained and many were eager to display their skills. Nevertheless, the physician was placed in direct charge of insuring that correct procedures were adhered to. With one exception, there was never an occasion when the results of the laboratory technicians were in question. The one exception, in Bimban (10), is elaborated on in the Results.

Selection of the Sample Population

A systematic sample was taken at each study site. The unit of selection was the family. All members of each family in the sample were examined. From each study site about 200 families were selected systematically from a list drawn up from the village or villages to be sampled that included all the families of the village or villages and all the members of each family. By selecting 200 families per health unit or center, a sample total of approximately 700 to 900 persons was estimated. The target sample size for all study sites in both studies was between fourteen and eighteen thousand. The family list was the sampling frame. For purposes of selecting the sampling unit (the family), the family was defined as a man, his wife or wives, and all unmarried offspring. This definition was easy to use and fairly stable, i.e., the average number of persons per family did not vary greatly from site to site, though in Upper Egypt the families were somewhat smaller. (Note that not all offspring of a selected married female may have been examined.) All selected family members were accounted for.

If a member did not attend the examination, an explanation of why the member was not present was stated on the family examination form. No attempt was made to replace those who would not come, were absent at the time of the survey, or had died.

To make the selection of the families, an up-to-date list of family names and members, or sampling frame, was required. Generally a frame was available but often out-of-date by four to five years. In order to avoid delaying the start of the survey, the following procedure was implemented. The total number of families in the old list was divided by 200. The number obtained, for example 3.4, was rounded off to the next higher number and added to one (2 or 3 in other cases depending on an estimate of how many new families would be added). In this example, with a starting list of 680, every fifth family would be selected starting from a random number between 1 and 5. The frame would immediately begin to be updated, adding new families at the end of the list, and the examination of the selected families starting from the first selected and proceeding sequentially was also begun. The up-dating was always finished long before the examination of the first selection of families could be completed. The selection of every fifth family according to this example would result in an under-selection, i.e. less than 200 would be selected. In this case about 136 families would be selected if 120 new families were added to the original list of 680. After the examination of 136 families, 64 families would have to be reselected from 664 remaining unselected families by selecting every 10th family. Reselection being made without replacement, a total of 202 families would be selected and examined. This approach was used throughout the study, with two or more samples (one or more reselections) from each site being taken in this fashion. Each selected family was circled and serially numbered in the list of family names and members.

The serial number for the family became the serial code number for that family. The members of the family were listed serially starting with the first person examined on the family examination data, form 01. This gave each individual that was examined in the survey a unique code number comprised of the number of the village, the family serial code number, and the individual code number within the family. The code number 01,001,01 identifies the first person in the first family selected at the health unit 01, Kazan Sharq. The health unit or center code number and the family serial code number were used to identify the data forms 01 and the housing data forms 02. The data form, 02, was completed for each house of each of the selected families. These forms were matched with the family 01 forms by coding the 02 forms with the health unit or center number, the house number, and family serial code number.

The same sample size (200 families) was used throughout the survey, rather than selecting a given proportion of the population at each site. Therefore, the sampling fraction varied from site to site. This was done for administrative reasons, and because it was desired that the completion of the survey of the families and the environment be roughly during the same period of time at all sites. The reason for this was that by carrying out the survey at the different sites over the same period of time, the possibility of seasonal variation of the parameters measured between the sites would be negated.

It was estimated that 200 families would yield a sample of about 800 individuals. This sample size was felt sufficient to give the estimates of the various parameters sampled with adequate precision at each site. The systematic selection of families was used as opposed to a purely random method for two reasons. One, the systematic selection more often than not gives greater precision. With a systematic selection, no isolated groups, individuals, or houses are left unrepresented in the sample, as might inadvertently happen with a random selection. Two, the selection of the families for examination could proceed immediately without waiting for an up-dated family list. A random sample would be impossible to select before the list was completed because the added group would not have a known possibility of being selected in the first round.

Examination of the Environment and the Population

Before the survey could begin, each health unit or center had to receive the necessary materials and the personnel had to review the methods for the correct filling in of the data forms and the correct method for preparing the stool and urine specimens. The up-dating of the family list was always the first activity, followed by the selection of the families. In order to obtain the cooperation of the village members, a meeting was held with the village council, the local physician and the field supervisor, to explain the purpose of the survey and solicit the aid of the council to overcome any difficulties. On occasion the director-general of the governorate attended these meetings. Only after the personnel at the health unit or center showed proficiency with the different aspects of the data acquisition was the examination begun.

Generally a routine was established where the sanitarian would go to the selected family's house, complete the housing form and instruct the family to go to the health unit or center the following day. The instructions included telling the family members that the information obtained would be held in strictest confidence and that specimens of stool and urine would be requested at the health unit or center. At the health unit or center, the selected family members would be given a numbered stool pan and a numbered tin cup and requested to provide a specimen of each at some point during the examination.

By obtaining the specimens from the selected family members at the health unit or center, proper identification of the specimens could be guaranteed. This is a unique feature to this survey. Scott (1937), Farooq and Nielsen (1966), and Zawahry (1963) all obtained their specimens by providing specimen containers to the heads of the household of each of the families selected.

There were exceptions, most notably at Kurta (8) in the resettled Nubian area. The water supply in the laboratory at Kurta (8) was the most inadequate of all the selected sites. The piped water supply was limited to a few hours a day and frequently failed for periods longer than 48 hours. Water rarely came to the health unit's laboratory. At Kurta (8), protected water was used first for drinking and cooking before it went for other purposes.

Because of this lack of water at the health unit,selected family members refused to give stool specimens. Under the circumstances, the methods of Scott (1937), Farooq (1966), and Zawahry (1964) were employed. Thus the correct specimen was obtained. Also, a large metal reservoir was given to the health unit laboratory so that water could be stored and available to clean equipment.

Trips to the field to initiate the survey activities were made in early April, 1976. By May, 1976 all units and centers had begun the collection of data. After the survey had begun, each field site was repeatedly visited. During these visits, additional materials were supplied, completed data forms and prepared specimens were picked up, and, if required, a reselection was made. In addition, a survey progress evaluation was made. This evaluation included the following:

1) a check to see if the names on the completed 01 and 02 forms corresponded to the names in the family list.

2) a check to see if the correct code numbers were being used.

3) a check to see if the code number on the specimen bottles corresponded to the code number on the family form 01.

4) a check to see that the housing forms 02 were being correctly completed. This was done by selecting

several completed forms and going to the respective homes and seeing if the completed forms agreed with the actual conditions.

5) a check to see if all the families in the village were included in the family list. This was done by going to the village and randomly selecting a house to see if the occupants were listed in the book. On no occasion was a family located that had not been included. It should be pointed out that, one, the sanitarians are well-trained in this respect; and two, they were often residents of the village who knew the villagers well, and were actually related to many of them.

6) to review any problems or obstacles being met and to resolve them.

7) to review the general progress, and to determine if the health unit or center was on schedule. Since only part of the working day could be allotted to the examination of the family members or the environment at the health unit or center, it was requested that approximately 20 persons per day, or five to six families, be screened at a time. The examination of the families and their environment at each site which was to be completed in about three months was actually 95% complete after five months.

8) to review the method of examination of the selected family members. This was done by observing the completion of the family form 01, with the physician at the health unit or center during a visit when examinations were being carried out. First, a family that had been examined just prior to arrival was recalled and re-examined, while checking the completed form for discrepancies. Secondly, the completion of the family form was followed through on a family who had not been examined. This was especially helpful in detecting errors in obtaining and preparing specimens. Idiosyncratic procedures were noted during this time. Those which did not in themselves affect the collection of data were usually allowed to continue, as changing procedure would risk causing errors.

9) confirmation of the methods used at the health unit or center for completion of the environmental data forms were reviewed in the same fashion as were employed for checking the housing forms.

10) on occasion, persons or families would come to the

health unit or center requesting to be included in the examination. If the person was elderly and a relative of a selected family or a village leader who had not been selected, forms were completed and specimens taken. No code numbers apart from the health unit number were given to these individuals. Data from these forms were not included.

11) an inventory of all the materials.

12) one of the most important checks was to see if the specimens of stool and urine were correctly examined, prepared, and labelled. From the very first it was stressed that the right stool and the right urine be placed in the right bottle in the correct manner. (The correct procedure was outlined for the laboratory technicians in Arabic.) This procedure was reviewed frequently at the health units and centers at the time when specimens were being provided by the selected individuals.

Data Management and Analysis

For this study, 3859 house data forms were executed for the examination of the dwelling units. An almost equal number were completed for the examination of the family. About 400 data forms were completed for the various environmental aspects of the village sites. Exactly 15,665 stool specimens were received. Ultimately, over 40,000 cards were keypunched.

When raw data in these quantities are obtained, major efforts have to be made to keep the data from being misplaced, lost, or damaged before it can be processed. This was aggravated by the distances involved between the 20 different study sites, as well as by the lack of good communication systems. Invariably staff at the health units faced problems after actually starting the survey that were not anticipated during the training phase. Most often the problem was solved by a change in coding procedure which did not affect the final accuracy. For example: on the housing form (02), in an unanticipated situation, the correct answer required the selection of more than one number, although only a single answer had been anticipated, and only one box had been provided on the data form. The examiners simply wrote in two numbers, or whatever the combination may have been, in the given box. This alteration was easily handled when the coding sheet was designed. The process was not always as uncomplicated as this and new combinations necessitated redesigning the code sheets.

To minimize problems of data management, a complete inventory of the number and amount of materials delivered and received from each study site was kept. Before data forms were accepted, they had to be checked for completeness, consistency, and accuracy.

All completed forms were packaged and delivered to the Cairo University Statistics Center. Code sheets were designed, tested, and re-designed. The final coding sheet for a particular form was reproduced at the center by offset printing.

Before transferring the data onto code forms, a code book or code key was developed for each type of data form. The questions on the family examination form 01 concerning diagnosis and medication received were the only examples of truly open questions, and required continued updating of the code book. The greater part of the coding was simply copying a selected number onto the code sheet.

Coded data were verified on a sample of forms from each site before punching. Punching formats were designed from the code sheets, i.e., data were punched directly from the code sheet. At the computer center printed listings of each site were made and checked against a sample of original data forms. For listing the data on magnetic tape, the punched cards were sorted by site, family, and individual, and a file on magnetic tape was created for each category of data form.

A series of Fortran IV programs were written at the Cairo University Statistics Center for use on a Data General 'Nova' computer. These programs were for:

1) preparing listings of various sub-sets of data.

2) basic tabulations of important variables in the data set. A number of tabulations were used to follow the work in the central laboratory, and were designed specifically to detect errors and inconsistencies made by the laboratory workers.

3) sequencing, matching, and renumbering of specimen data.

4) validating and examining the consistency of coded data.

5) eliminating duplicates in the specimen data.

6) writing the data set onto magnetic tape files.

The complete data set stored on magnetic tape was transferred to the University of Michigan's computing center for continued analysis. At the University of Michigan the Michigan Terminal System (MTS) and the Michigan Interactive Data Analysis System (MIDAS) was used to:

1) re-edit various sub-sets of data based on the results of verification programs run in Egypt.

2) match and merge the data from the family examination with the data from the specimen forms and housing forms for the creation of a master data file.

3) to complete, following step number two, the descriptive analysis and the assessment of relationships between variables in the data were completed.

Adjustment Scheme

Since the sampling fraction and the age structure of the sample varied from study site to study site, an estimate of prevalence made by simply adding together all those infected and dividing by the total number sampled in a given area, for example in Kafr El Sheikh, would be incorrectly weighted. To adjust for this, a procedure was formulated using a series of MIDAS commands. An estimated number infected was calculated for each age-sex group for each site in a given area of study. The age-sex specific prevalence at each site was used to make these estimates. The estimated numbers infected in each age group for each site were added together and divided by the sum total of the population of all villages studied in the area. This result was the adjusted age-specific prevalence. The sum of all these estimated to be infected divided by the total population from all sites equalled the over all adjusted prevalence for a given area. Sex-specific adjusted prevalences were calculated using the same procedure, but selecting only male or female cases.

CHAPTER IV

RESULTS

The results have been divided into two major subheadings. Under the first subheading is the results of the study conducted in the rural downstream villages in the governorates of Aswan, Beni Suef, and Kafr El Sheikh. Under the second subheading is the results of the study conducted in the resettled Nubian villages of Kom Ombo.

Results of the Downstream Study

Selection of the Sample and Response

The study sites or villages where survey data were collected were given the code number assigned to the health unit or center which serviced the village or villages sampled. Summarized in Table 27 are the code numbers for each village or site and the name of the corresponding health unit or center and by site the number of persons examined, the number of families examined, the number of persons not giving a urine specimen, the number of persons selected but not attending (the so-called non-respondents), the number of houses examined, and the population at each sampled site. The probability of being selected from the total population sampled was 0.181. The population of all villages sampled in the Downstream Study sites totaled 66,768 persons. The total number of persons sampled was 12,059. The probability of being selected was not constant from site to site, ranging from 0.08 to 0.58. Because the selection probability varied, grouped estimates of all sites for a given area required the appropriate weighting based on the sampling fractions. Of those selected, 93.2% attended. Of the persons who attended the examination, 6.0% did not give a specimen. (11,555 specimens in all were examined.) The variation in response between study sites was quite marked, particularly in the villages sampled by health units numbered 4 and 11. If these two sites are excluded the response rate is increased to 96.7%. There were 3020 houses for which data were obtained, although only 2894 families attended the examination. Apparently, there were 126 families who allowed their homes to be examined and had intended to come to the examination but were unable to do so. In many of the village sites everyone selected participated. The very good response obtained in this study is a remarkable testimony of cooperation by these village people.

Age-Sex Distribution of the Sample

The number of persons by area selected and attending the examination at the health units or centers is shown in Table 28 by 5 year age groups, except for the first age group which shows the number of infants less than one year of age, and the last age group which combines all those persons 65 years or older. Tables 29 through 31, show the number of persons by age, sex, and study site and their respective distributions. Generally there was little marked difference between the proportional size in like age groups within given area studied, i.e., for a given area the age-sex structure was very similar from site to site. Figures 15 through 17 show the distribution of the age structures between sites for each area studied and graphically demonstrate these similarities. However, the chi square test indicated that the differences in age structure between sites in all three areas were statistically significant ($p<0.01$) indicating that adjustment for age structure is necessary when estimating various parameters within a given area or between areas. Sex ratios were not statistically significant between sites, but were significant between the three different study areas (chi square, $p<0.01$).

Figures 18 through 20 were prepared to show the relationship between the sample age structure and the age structure based on the 1960 (CAPMAS, 1960) census for each of the respective rural areas. The resemblances between the age curves of the sample to the census age structure show that as far as population structure is concerned the study sites are representative of the areas from which they were selected.

Overall Prevalence of Schistosomiasis in the Study Areas

Kafr El Sheikh

The number of persons in the sample from all village sites in the Kafr El Sheikh area positive for S. haematobium was 1,257 or 28.5% of the sample, and for S. mansoni, 861 persons or 19.6%. There were 336 persons (7.7%) who were positive for ova in the stool or urine for both species and 1,782 persons (40.3%) who were infected with either

Table 27
The Pattern of Selection and Response in the Downstream Study Sites.

Study Area	Study Site Code	Number of Persons Examined	Number of Families Examined	Number of Persons Not Giving a Specimen	Number Selected But Not Attending	Number of Homes Examined	Population
Aswan	1	908	196	25	46	202	2371
	2	993	224	46	89	237	4021
	3	508	124	46	42	140	1915
	4	785	210	29	266	224	4701
	10	537	193	36	0	191	3076
Beni Suef	11	384	108	20	244	186	8958
	12	646	200	129	0	200	4961
	13	920	213	68	0	226	1610
	14	751	199	47	0	198	6777
	15	776	198	20	0	200	9250
Kafr El Sheikh	16	916	199	0	0	200	4135
	17	984	211	15	93	200	2937
	18	896	197	14	5	200	2031
	19	837	204	82	89	298	2700
	20	1018	218	145	0	218	7325
Total		12059	2894	722	874	3020	66768

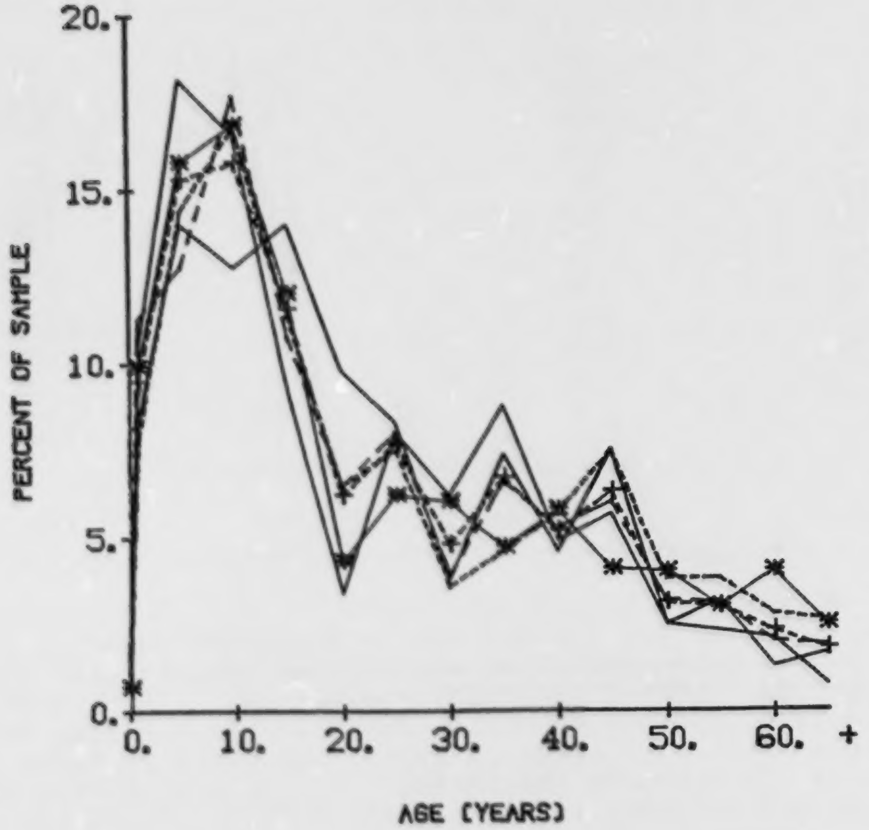

Figure 15. The age distribution by study site in the Kafr El Sheikh study area. Each line represents a study site. The zero on the abcissa represents infants less than one year old. The next point represents the age group 1 to 4; the next, 5 to 9, 10 to 14, and continues in five-year age groups.

Table 28
The Number of Persons Attending the Downstream Study by Age and Area.

Age Group	Study Area		
	Kafr El Sheikh	Beni Suef	Aswan
0<1	66	103	42
1-4	518	442	206
10-14	724	510	550
15-19	521	365	385
20-24	284	211	245
25-29	344	215	211
30-34	214	207	184
35-39	294	214	227
40-44	237	207	225
45-49	275	144	179
50-54	146	178	197
55-59	140	87	96
60-64	115	114	109
65 +	88	111	91
Total	4651	3677	3731

S. haematobium or *S. mansoni* or both. Those infected with either one or both species of schistosome comprise the group of infected termed "schistosomiasis". The overall uncorrected prevalence of schistosomiasis in the Nile Delta study area is 40.3%. These figures are given in Table 32. The percent positive in the sample from all sites for this area does not correspond to an estimate of prevalence for all sites because of differences in population structure between the study villages and because of the variation in the probability of selection between sites. Adjustments for both age and sampling fraction were made according to the techniques described in Materials and Methods. Briefly, the appropriate weights were given to each age group according to the age structure and sampling probability for a given parameter measured by the study and then added across age groups for each site.

The adjusted estimates of prevalence for the Kafr El Sheikh area and the standard error (a measure of sampling precision) are also given in Table 32. The estimate of prevalence and standard error for *S. haematobium*, *S. mansoni*, for infections with both species and for infections with either or both species by each study site is shown in Table 33. *S. mansoni* was lower in prevalence than

Table 29
The Number of Persons Examined in Kafr El Sheikh by Age and Site.

Age Group	Study Site Code Number				
	16	17	18	19	20
0<1	6	8	8	15	29
1-4	77	102	101	98	140
5-9	128	154	115	115	173
10-14	117	165	156	130	155
15-19	128	117	97	88	91
20-24	90	43	59	52	40
25-29	76	60	71	63	74
30-34	35	59	34	30	56
35-39	68	46	60	35	85
40-44	42	57	48	45	45
45-49	69	41	53	59	53
50-54	23	39	30	31	23
55-59	29	29	28	31	23
60-64	12	39	19	22	23
65 +	16	24	17	23	8
Total	916	984	896	837	1018

S. haematobium at all study sites except 19. There was a very high correlation ($r=0.967$) between the prevalence of the two species by site indicating that if the prevalence of one organism was high the other would also be elevated. It follows that, if the conditions for transmission for one of the species was good it is probable that transmission for the other was also good for a given area. The prevalence of schistosomiasis was quite varied from site to site and statistically significant (chi square, $p<0.01$), being more than twice as high in El Aarzine (16) as in Mahalet Mousa (19). The differences in prevalence between sites were more marked for *S. haematobium* than for *S. mansoni*.

It should be borne in mind that these prevalence figures and the ones to follow are based on a single examination of urine or stool. Farooq and Nielsen (1966) showed that successive examinations increased the number found positive, and Weir, *et al.* (1952) using rectal snips indicated that the technique, examination of the excreta for characteristic schistosome ova, was very insensitive in respect to false negatives. Data are not available concerning the quantitative relationship between different levels of prevalence and false negatives. It suffices to

Table 30
The Number of Persons Examined in
the Beni Suef Study Area by Age and by Study Site.

Age Group	Study Site Code Number				
	11	12	13	14	15
0<1	9	29	26	26	13
1-4	55	21	99	91	76
5-9	47	133	153	130	106
10-14	59	123	145	85	98
15-19	43	61	108	63	90
20-24	23	54	47	30	57
25-29	24	50	57	46	38
30-34	18	57	44	48	40
35-39	23	48	57	45	41
40-44	26	43	46	32	60
45-49	16	27	38	30	33
50-54	14	31	31	41	61
55-59	7	21	22	25	12
60-64	13	19	20	27	35
65 +	7	29	27	32	16
Total	384	846	920	751	776

say that meaningful comparisons can be made only when methodologies are similar. No attempt was made during this study to determine the proportion of cases remaining negative after successive examinations. Therefore, to most accurately show relative changes in prevalence, comparisons require that the separate data sets are not adjusted for false negatives. It would be invalid to evaluate changes in prevalence figures between different studies which had used different methods for detection and estimation. So long as the same sampling, examination, and estimation techniques are adhered to, meaningful comparisons can be made.

Beni Suef

In the five study sites in the Beni Suef governorate, 3391 specimens were examined for schistosome ova. The number of persons positive in this sample was 951. Prevalence between study sites varied significantly (chi square, $p<0.01$) with a high of 37.3% positive in Naiim (13), and a low of 16.9% in Shrief Pasha (12). Standard errors were calculated for the prevalence of schistosomiasis at

Table 31
The Number of Persons Examined in the Aswan Area by Age and by Site

Age Group	Study Site Code Number				
	1	2	3	4	10
0<1	27	11	2	0	2
1-4	104	92	80	84	46
5-9	158	118	76	143	90
10-14	133	150	60	137	70
15-19	93	125	52	58	56
20-24	40	92	47	29	37
25-29	50	62	27	41	31
30-34	52	37	30	28	37
35-39	54	68	23	47	35
40-44	59	57	22	51	36
45-49	42	51	22	46	18
50-54	43	50	30	44	30
55-59	22	24	14	16	20
60-64	19	30	14	36	70
65 +	12	26	9	35	9
Total	908	993	508	785	537

each site and are shown in Table 34. Because the age structure and sample fraction differed from site to site, the overall prevalence for all sites in the Beni Suef area was adjusted in the same fashion as described for Kafr El Sheikh. The overall adjusted prevalence for schistosomiasis was 26.7%. The adjusted prevalence was a few points less than the unadjusted crude prevalence of 28.1%. The prevalence of schistosomiasis in the Kafr El Sheikh study sites was more than one and a half times higher, even after adjusting for differences in age-sex structures between the two populations, than that of the Beni Suef study sites--and this is highly significant. Although the differences were not as great, the adjusted prevalence for S. haematobium alone in the Kafr El Sheikh sites was also higher than in Beni Suef and significant (chi square, $p<0.001$). There were 20 persons in the sample positive for S. mansoni ova, less than one percent of the sample. It is not known whether or not these persons had made previous visits in the Nile Delta. It should be noted that 63% of these cases were clustered in one village (Barout), and one case was detected in a one year old infant.

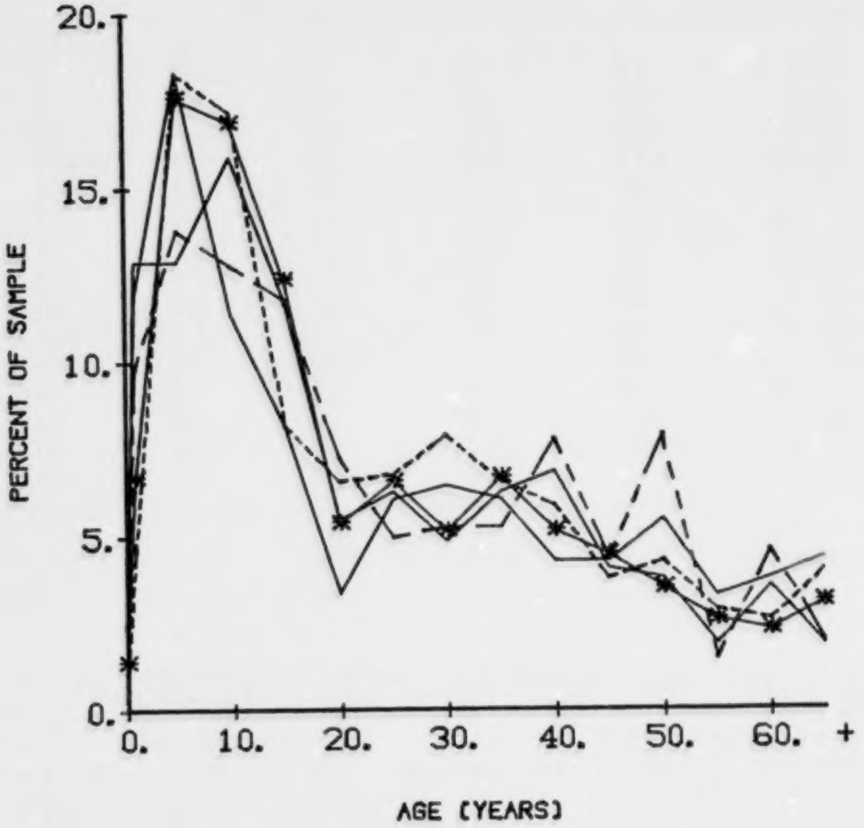

Figure 16. The age distribution by study site in the Beni Suef study area. Each line represents a study site.

Table 32
The Overall Prevalence of Schistosomiasis in the Kafr El Sheikh Study Area.

Type of Infection	Number of Specimens Examined	Number of Specimens Positive	Percent Positive	Percent Positive Adjusted*
S. haematobium	4404	1257	28.5	30.04±0.78
S. mansoni	4402	861	19.6	20.0±0.32
Both Species	4386	336	7.7	8.0±0.20
Either One or Both	4421	1782	40.3	42.1±0.39

*Adjusted for sampling fraction and age structure between study sites. The figures following the plus and minus sign are the standard errors.

Aswan

In the five selected sites within the Aswan governorate, 3728 specimens were examined for schistosome ova; 180 were positive for S. haematobium or 4.8% of the sample. Variation in prevalence of schistosomiasis between sites was significant (chi square, $p<0.01$), with a low of 0.2% in Guzaiera (2); and highest in Bimban (10), which was 7.8%. Standard errors and adjustments for age structure and sampling fraction were calculated using the same methods as described in the two other study areas. Table 35 shows these results.

In Bimban (10), a subsample of 40 families was selected and examined. This subsample was initiated because of observed deficiencies in the laboratory personnel. This was the only site where incorrect procedure was observed. Bimban (10), by virtue of its location on the west bank of the Nile River, is considerably more isolated than villages located on the east side of the river. Villages on the east bank can be easily accessed by the Aswan-Cairo Motorway (see map, Figure 11). To reach Bimban (10), the Nile River must first be crossed in the Nile sailing vessel, the "Falucca", which is the only available means in this locale. The Bimban (10) Health Center is another 4.5 kilometers from the docking area on the west bank, and is reached either by foot or by donkey. The health center's ambulance, the only

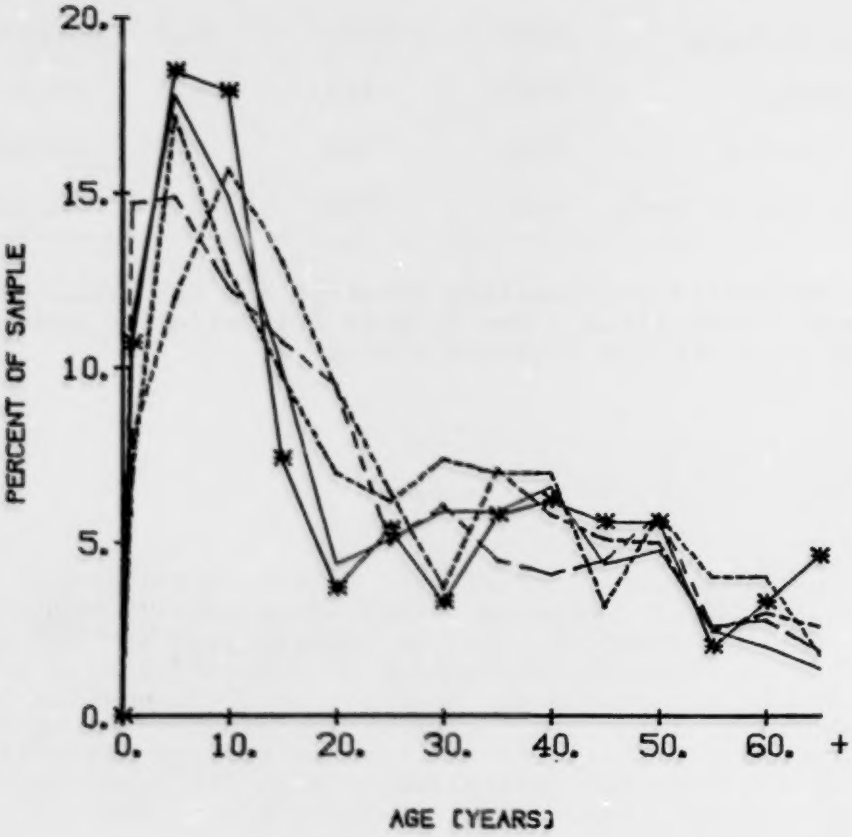

Figure 17. The age distribution by study site in the Aswan study area. Each line represents a study site.

Table 33
The Overall Prevalence of Schistosomiasis by Study Site in the Kafr El Sheikh Study Area

Study Site Name	Study Site Code	Percent Positive			
		S. haematobium	*S. mansoni*	Both	Schistosomiasis Either or Both
El Agazein	16	52.8	28.4	14.7	66.5
El Hamra	17	34.0	24.2	9.1	48.9
Mahalet El Kasab	18	21.2	15.4	6.6	31.2
Mahalet Mousa	19	11.4	13.7	3.6	21.5
Sheno	20	19.0	14.2	4.5	28.2

Table 34
Prevalence of S. haematobium in the Beni Suef Study Sites, Upper-Middle Egypt.

Study Site Name	Study Site Code	Number Examined	S. haematobium % Positive
Barout	11	325	27.5
Shrief Pasha	12	710	16.9
Naiim	13	857	37.3
Beni Adi	14	708	29.4
Ashmant	15	758	27.4
		3418	26.7±0.25*

* Adjusted for sampling fraction and age structure. Standard error follows the plus and minus sign.

motorized vehicle in the village, was under repair throughout the period of the survey. The personnel staffed at the Bimban (10) Health Center invariably resided either in Daraw or in Kom Ombo on the east side of the river and commuted daily. Because of these and other undesirable working conditions, absenteeism was high, and there was a continuous turnover in the staff of the health center. It suffices to say that communication and administrative control were hampered. A number of approaches were suggested to help improve the collection of data at Bimban (10). One likely alternative way was to permanently house the necessary staff in facilities available at the health center. This suggestion was not approved by the Aswan Director-General of Health, who feared that, "once one becomes comfortable in the bath, it may be undesirable to leave". Although the rationale behind this analogy was not clear, it was not pursued. Since there had also been numerous complaints by the staff about cooperation of the selected villagers, it was decided that a subsample would be drawn of 40 families or about 100 or more individuals, and that the physician at the health center would carry out all laboratory examinations of the urine specimens. The subsample was drawn by selecting every 5th family from the original selected sample of families. The subsample, therefore, was not independently selected. Therefore, those selected in the subsample were examined twice. It is

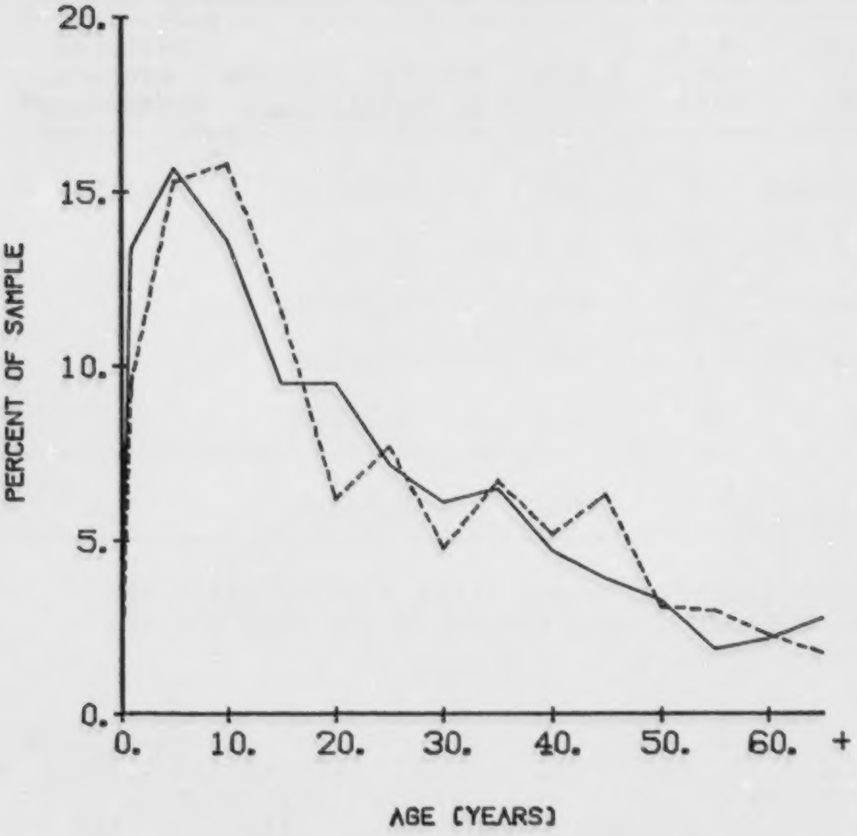

Figure 18. The adjusted age distribution from the Kafr El Sheikh study area and compared to the age distribution for this same rural area according to the 1960 census data (CAPMAS, 1960). The solid line represents the data from CAPMAS (1960), the dashed line, from the sample.

Table 35
Overall Prevalence of S. haematobium in
the Study Sites of the Aswan Governorate.

Study Site Name	Study Site Code	Number Examined	Percent Postive S. haematobium	Adjusted Overall Prevalence*
Kazan Sharq	1	984	6.9±0.9	4.1±0.2
Guzaira	2	947	0.2±0.1	
Abu Rish	3	474	4.2±0.9	
Ga'afra	4	760	5.9±0.9	
Bimban	10	663	7.8±0.4	
Totals		3728	4.8±0.4	

*Calculated on study sites 1 to 4 only. The figures following the plus and minus sign age the standard errors.

unlikely that new infections were acquired by individuals in the subsample in the time period between their first and second examinations but this possibility must be borne in mind. It is especially unlikely in light of the large increase in the number of positives detected on re-examination, and this confirms the observation that correct laboratory techniques had not been adhered to. Thirty-seven, or 24.8% of the subsample were found positive for schistosomiasis. These findings are given in Table 36. Prevalence was found to be over six times higher than the adjusted prevalence for the other four study sites combined in the Aswan study area, which was 4.1%.

In the overall sample from all areas and sites, more persons were infected with schistosomiasis in the Nile Delta than in any given study site or sites south of the delta in Beni Suef or in Aswan. In turn, the overall adjusted estimate of the prevalence was much higher in Beni Suef than in any of the study sites sampled in Aswan.

Age-Sex Distribution of Schistosomiasis in the Study Areas

Table 36
Results of the Subsample in Bimban, Aswan.

Parameter	Result
Number selected	149
Number examined	149
Number positive for *S. haematobium*	37
Percent Positive	24.8±3.5%
Sampling Fraction	0.04584

Kafr El Sheikh

Tabulation of the number examined and the percent positive in the entire sample from this area, for both species, and for either one or both infections by 5 year age groups and by sex are given in Table 37. This analysis shows that the age group with the highest proportion of the sample infected with schistosomiasis, i.e., either one or both infections, was in the 15-19 year olds. This was true for both sexes with the males bearing a significantly higher proportion of the infection. Figure 21 shows the age-sex prevalence distribution of schistosomiasis for all sites after adjusting for sample fraction and differences in age structure between sites.

The age distribution of *S. haematobium* infection in the sample and for the adjusted figures was significant (chi square, $p<0.01$) showing a rapid increase in the early years, peaking in the adolescent years and dropping by adulthood, in the early 20's. This is a typical feature of schistosomiasis infections and can be seen in Figures 21 to 24 which show the adjusted distributions by age and sex for schistosomiasis, *S. haematobium*, *S. mansoni*, and infection with both species, respectively. The distribution of prevalence by age for *S. mansoni* (Figure 23) was not as marked as for *S. haematobium* and has an atypical rise in prevalence in the older age groups. This was more evident in the males than in the females. Farooq, *et al.* (1966) comments on the differences in the age distributions between *S. haematobium* and *S. mansoni* and notes that *S. mansoni* does not fall as sharply in the adult age groups as does

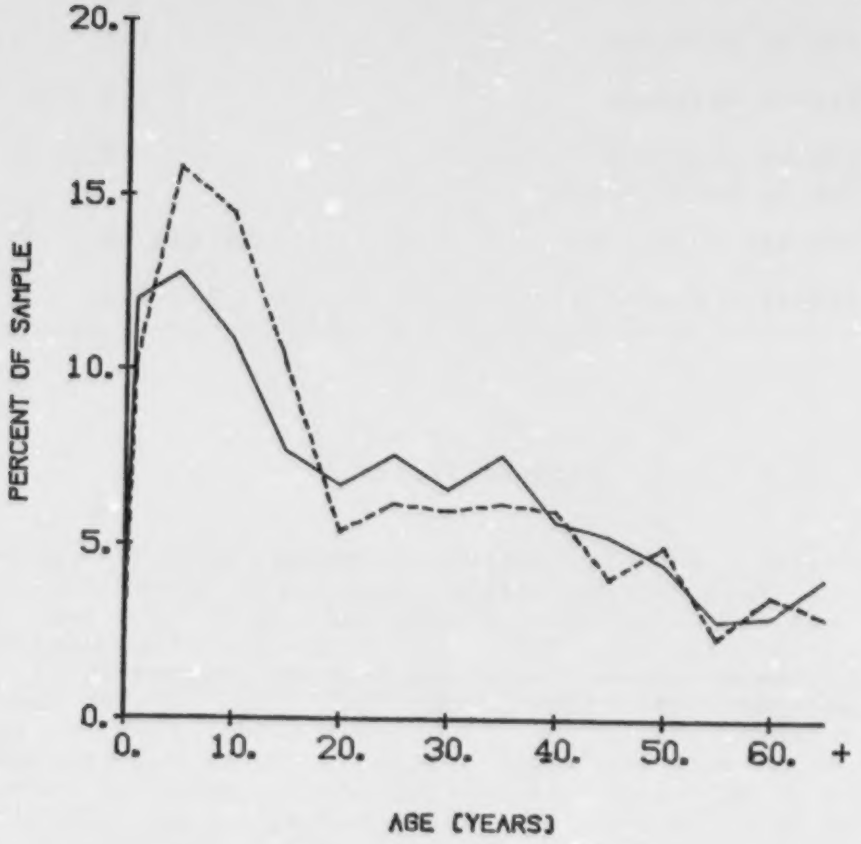

Figure 19. The adjusted age distribution from the Beni Suef study area compared to census data for this area (CAPMAS, 1960). The solid line is the data from CAPMAS (1960), the dashed line, from the sample.

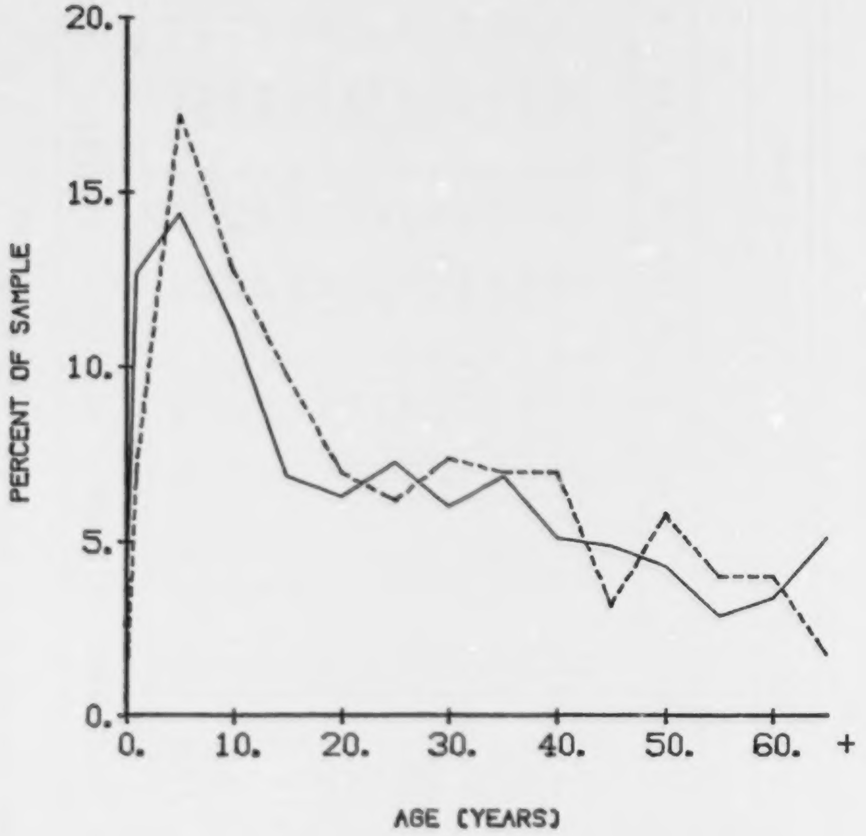

Figure 20. The adjusted age distribution from the Aswan study area compared to census data this same region (CAPMAS, 1960). The solid line is the data from CAPMAS (1960), the dashed line, from the sample.

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Table 37

The Number Examined and Percent Positive by Age and Sex in the Kafr El Sheikh Area for All Those Infected with Both S. haematobium and S. mansoni and Infected with Either or Both Species.*

Age group	Infected with Both Species						Either or Both					
	M		F		T		M		F		T	
	# Ex.	%	# Ex.	%	# Ex.	%	# Ex.	%	# Ex.	%	# Ex.	%
0<1	15	0.0	16	0.0	32	0.0	15	6.2	17	11.8	32	9.4
1-4	214	0.9	209	0.5	425	0.7	216	19.4	212	16.9	428	18.2
5-9	362	4.9	298	5.0	662	5.0	365	34.4	300	32.4	665	33.5
10-14	352	13.5	352	10.5	704	12.0	355	54.2	355	49.3	710	51.8
15-19	258	15.4	246	10.9	506	13.2	258	60.6	249	50.6	508	56,7
20-24	138	12.8	127	4.8	268	8.9	142	52.8	129	32.8	271	43.8
25-29	151	9.5	183	6.0	334	7.8	151	50.3	183	41.2	334	45.2
30-34	103	10.6	104	3.8	208	7.2	104	40.4	104	34.6	2.8	37.5
35-39	130	10.0	153	8.4	284	9.2	130	50.0	159	38.3	284	43.7
40-44	105	9.5	125	5.6	231	7.4	105	49.5	126	27.8	231	37.7
45-49	131	8.4	138	4.3	269	6.3	132	50.0	139	25.9	271	32.6
50-54	67	14.9	74	2.7	141	8.5	67	46.3	74	28.4	141	36.9
55-59	69	17.4	65	4.6	134	11.2	69	53.6	65	27.7	134	41.0
60-64	59	3.4	49	4.1	108	3.7	60	18.3	49	306	109	23.9
65 +	36	5.6	48	2.1	84	3.6	37	43.2	48	25.0	85	32.9
Total	2190	9.6	2187	6.2	4395	7.9	2207	44.8	2204	35.6	4411	40.2

*Those without age information were not included.

S. haematobium. *S. mansoni* seems to be acquired slower and to persist longer than *S. haematobium* infections. The wide spread between the age prevalence of schistosomiasis and those infected with both species (see Figure 25) does suggest separate transmission sites and supports this view.

Beni Suef

The number of persons positive for *S. haematobium* in the Beni Suef area by five year age groups and by sex is shown in Table 38. As in the Kafr El Sheikh sites the 15-19 age group had proportionately the highest prevalence. The number of females infected was less than the males for every age group. Age and sex distributions were significant (chi square, $p<0.01$) for both adjusted and un-adjusted figures in the Beni Suef area. Proportionately fewer females were infected in Beni Suef than in the Kafr El Sheikh sample. The prevalence was 2.08 times greater in the males in the Beni Suef sites than in the females, whereas the prevalence was only 1.4 times higher in males in Kafr El Sheikh. Figure 26 shows the age-sex prevalence (after adjustment) for *S. haematobium* in Beni Suef.

Aswan

The age-sex adjusted prevalence curves for *S. haematobium* have been prepared in the same manner as for the results from Kafr El Sheikh and Beni Suef and are shown in Table 39 and Figure 27. Bimban (10) was not included with these results, but was treated separately because it was not a desert type village. Results of the age-sex prevalence tabulations for the sample and the subsample from Bimban are given in Table 40. Bimban (10) was originally selected as a site that was not typical of this region, but rather isolated and located in an area more similar to the condition of other villages located in a flat irrigated plain. The elevated prevalence of schistosomiasis in the subsample from this study site indicates that the conditions for transmission were strikingly different from those at the other four study sites, all of which had uniformly low prevalence.

Schistosomiasis prevalence was highest (13.3%) in the age group 10 to 14 years old for these study sites numbered 1 to 4 grouped together. This is one age group younger than the age group of highest prevalence in the two northern areas of Kafr El Sheikh and Beni Suef. Prevalence in the males was over 4 times higher than in the females. In Bimban (10), the age prevalence was slightly erratic, with a high variance most likely due to the small size of the

Table 38
Age-Sex Distribution of S. haematobium
Infection in the Sample from the Beni Suef Area.

Age Group	Infected with S. haematobium					
	Males		Females		Total	
	# Examined	%	# Examined	%	# Examined	%
0<1	20	0.0	21	0.0	41	0.0
1-4	158	5.1	137	5.1	295	5.1
5-9	312	30.8	249	14.5	561	23.7
10-14	265	59.7	237	38.8	502	49.6
15-19	200	69.0	155	37.0	355	55.2
20-24	71	50.7	121	22.3	192	32.8
25-29	96	38.5	113	10.6	209	23.4
30-34	85	32.4	120	14.2	205	22.0
35-39	102	39.2	108	11.1	210	24.8
40-44	92	38.0	108	8.3	200	22.0
45-49	68	19.1	75	9.3	143	14.0
50-54	77	23.4	97	14.4	174	18.4
55-59	50	32.0	34	8.8	84	22.6
60-64	61	29.5	53	11.3	114	21.1
65 +	69	14.5	39	5.1	108	11.1
Totals	1726	37.7	1667	18.1	3393	28.1

population in the subsample. Males had more schistosomiasis than females, but the ratio was similar to that in the study sites of Beni Suef: 2.6.

Environmental Aspects of the Downstream Study Sites

Kafr El Sheikh

In the past the villages in Kafr El Sheikh governorate had obtained their domestic water supply from the nearby canals and drains, or, where available, from public standpipes supplied by deep wells. (A standpipe is defined as a public water outlet of one or more taps attached to a vertical water pipe that may or may not have additional support, but typically are attached to a vertical concrete slab.) Since 1958, the standpipes have been supplied by a water treatment plant at Fowa. This is a typical tertiary water treatment plant; however, pressure in the distribution

Table 39
The Number Examined and the Percent Positive by Age and Sex for S. haematobium in the Aswan Study Area Excluding the Results from Bimban (10).

Age Group	Infected with *S. haematobium*					
	Males		Females		Total	
	# Examined	%	# Examined	%	# Examined	%
0<1	13	0.0	17	0.0	30	0.0
1-4	156	0.0	170	2.9	325	1.5
5-9	235	7.7	245	2.0	480	4.8
10-14	255	20.8	218	5.0	473	13.5
15-19	156	12.2	162	1.9	318	6.9
20-24	78	5.1	123	0.0	201	2.0
25-29	55	1.8	116	0.9	171	1.2
30-34	47	2.1	93	1.1	140	1.4
35-39	61	0.0	123	0.8	184	0.5
40-44	78	1.3	101	1.0	129	1.1
45-49	68	1.5	82	0.0	150	0.7
50-54	75	1.3	8.3	0.0	158	0.6
55-59	45	0.0	28	0.0	73	0.0
60-64	46	0.0	38	0.0	84	0.0
65 +	43	0.0	38	0.0	81	0.0
NS*	12	8.3	5	0.0	17	5.9
Total	1423	7.0	1642	1.7	3065	4.2

* Not Stated.

system is not always continuous, due to demand. The number of standpipes by study site, the number of persons per standpipe, and the prevalence of schistosomiasis by study site is shown in Table 41. There seems to be no obvious relationship between schistosomiasis prevalence and the number of persons per standpipe, which ranges from 540 to 207. Table 42 shows the number of persons in the sample by source of water and by the type of use. Since the use of different water sources is not exclusive, the numbers show a measure of preference by the persons in the sample. It is evident that outside pipes (standpipes) were the most commonly used source of drinking water, but the other water use activities, such as bathing, were frequently divided between the protected sources and the canals or drains.

An analysis to determine the relationship between

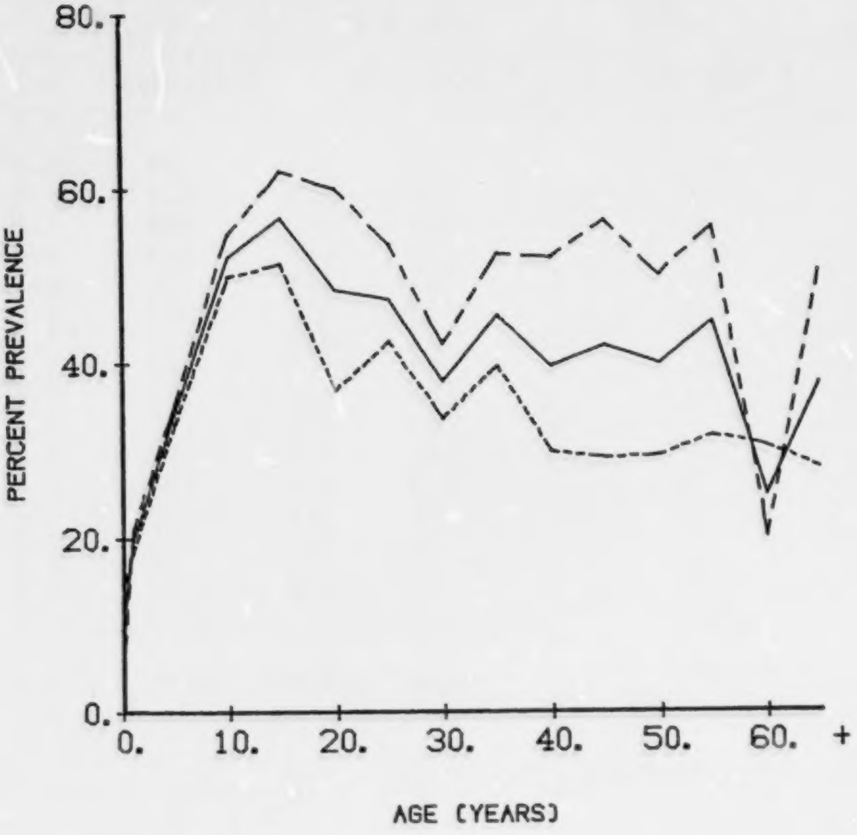

Figure 21. The adjusted age-sex prevalence distribution for schistosomiasis for all study sites combined in the Kafr El Sheikh study area. The long dash corresponds to males, the short dash to females, and the solid line for the total.

Table 40
The Number Examined and the Percent Positive by Age and Sex
for *S. haematobium* in the Bimban (10) Subsample.

Age Group	Infected with *S. haematobium*					
	Males		Females		Total	
	# Examined	%	# Examined	%	# Examined	%
0<1	0	0	1	0	1	0.0
1-4	2	0	5	0	7	0.0
5-9	7	86	11	33	18	55.6
10-14	12	50	12	11	24	29.2
15-19	12	33	10	10	22	31.8
20-24	10	60	3	33	13	53.8
25-29	5	20	3	0	8	12.5
30-34	3	100	8	20	11	36.4
35-39	1	0	6	17	7	14.3
40-44	7	0	6	0	13	0.0
45-49	2	0	2	0	4	0.0
50-54	4	0	4	0	8	0.0
55-59	3	0	1	0	4	0.0
60-64	2	0	3	0	5	0.0
65 +	3	0	1	0	4	0.0
Total	73	36	76	14	149	24.8

schistosome infection and the source of water did not show any distinctive patterns until all those who had scored the data forms for more than one source were eliminated in the piped inside and piped outside categories, the rationale being that if an individual obtained water from an unprotected source as well as a protected one it would confound the impact on the evaluation of the protected supplies. The results shown in Table 43 by source and use of water are combined data for all study sites in Kafr El Sheikh. Those persons fortunate enough to have water piped into their homes and who did not supplement this supply with sources from outside the home had lower prevalence than those who obtained their drinking water solely from standpipes. The latter group, in turn, had a lower prevalence than those who used the canals as a source. This observation was consistent regardless of what the water was used for and showed an even greater differential for *S. mansoni* infections, which is given in Table 44.

In the Kafr El Sheikh study, 90% of the sample had latrines. Prevalence of either species was not significantly different between those having a latrine or

Table 41
The Prevalence of Schistosomiasis and the Distribution of Persons per Standpipe in the Kafr El Sheikh study area.

Study Site Code	# Standpipes	Persons per Standpipe	Schistosomiasis Percent Prevalence
16	20	207	66.5
17	7	420	45.9
18	4	508	31.2
19	5	540	21.5
20	28	262	28.7

Table 42
The Number of Persons in the Sample from Kafr El Sheikh by Water Source and Use.

Water Source	Water Use				
	Drinking	Bathing	Laundry	Utensils	Animals
Piped inside	197	193	105	85	29
Piped outside	4183	3631	2909	2878	121
Hand pump inside	12	57	57	57	2
Hand pump outside	8	10	10	2	0
Canal	909	3091	2993	2927	2822

not having one.

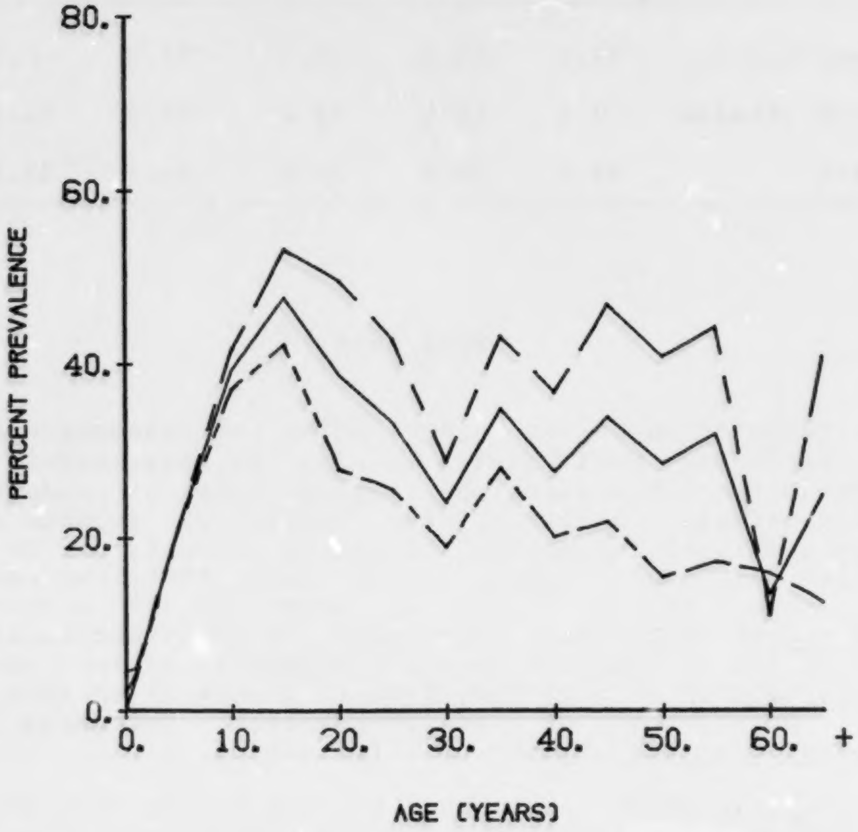

Figure 22. The adjusted age-sex prevalence distribution for S. haematobium infections for all study sites in the Kafr El Sheikh study area. The long dash corresponds to males, the short to females, and the solid line for the total.

Table 43
The Percent Prevalence of S. *haematobium* by Source and Use of Water Supply from Kafr El Sheikh study area.

Water Source	Water Use				
	Drinking	Bathing	Laundry	Utensils	Animals
Piped inside	13.3	13.3	13.3	13.3	0.0
Piped outside	19.2	20.0	18.2	18.0	16.7
Canal	33.3	32.8	34.6	34.6	32.9

Beni Suef

Table 45 shows the distribution of standpipes in the study sites of Beni Suef. Again, no relationship seems evident between the number of persons using a standpipe and schistosomiasis prevalence. The number of persons in the sample and their respective sources of water by use is given in Table 46. Hand pumps, often seen installed near the canals, are a common source of water in this area. When water source data and prevalence of schistosomiasis were adjusted for multisource uses a distinctive pattern emerged, similar to that seen at the Kafr El Sheikh sites (see Table 47). Prevalence of schistosomiasis decreased with improvement in the quality of water source.

Only 37.3% of the houses in the sample from the Beni Suef area had latrines. The persons residing in homes that had latrines had less schistosomiasis, 22.6%, than those who did not, 31.4%.

Aswan

There seems to be a consistent lack of relationship between the number of persons per standpipe and the prevalence of schistosomiasis. Data from the study sites in Aswan, and tabulations for the number of persons per standpipe (given in Table 48) are in accordance with this observation. In the study sample from sites 2, 3, and 4 (Guzaria, Abu Rish, and Ga'afra, respectively) water sources for domestic use were obtained invariably from standpipes. Only small irrigation canals are found in the area where

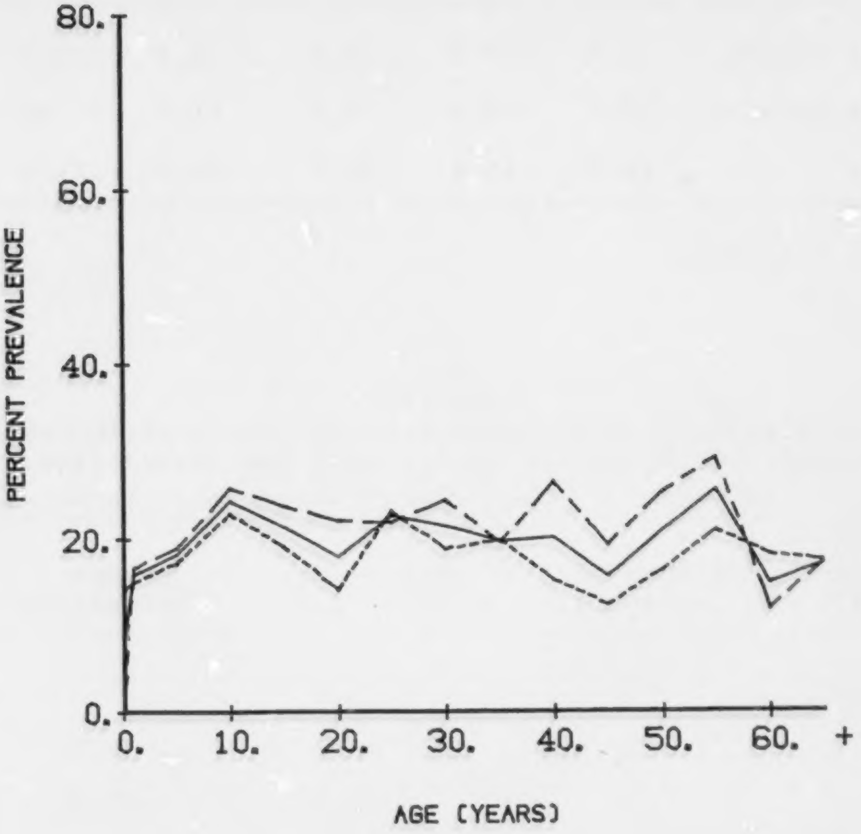

Figure 23. The adjusted age-sex prevalence distribution for *S. mansoni* infections for all study sites in the Kafr El Sheikh study area. The long dash corresponds to males, the short dash to females, and the soled line for the total.

Table 44
The Percent Prevalence of S. mansoni by Source and Use of Water Supply in the Sample from Kafr El Sheikh.

Water Source	Water Use				
	Drinking	Bathing	Laundry	Utensils	Animals
Piped inside	6.7	6.7	6.7	6.7	ND*
Piped outside	12.3	12.8	11.9	11.7	ND
Canal	24.7	21.4	22.1	22.0	21.2

* No Data

Table 45
The Prevalence of Schistosomiasis and the Distribution of Persons per Standpipe in the Beni Suef Study Area.

Study Site Code	Number of Standpipes	Persons per Standpipe	Percent Prevalence
11	0	0	27.5
12	6	827	16.9
13	8	201	37.3
14	7	968	29.4
15	13	712	27.4

these villages are located, and are at inconvenient distances from the villages, thus precluding their use in favor of the standpipes. In Kazan Sharq (1), the Nile was the exclusive source of water. It should be mentioned that there are nc upstream populations from Kazan Sharq (1); the village is very near the outfall of the old Aswan Dam, where the water quality of the River Nile in Egypt is at its best. Approximately one month following the field work in Kazan Sharq (1) standpipes were installed throughout the village and supplied by the new Aswan water treatment plant. Water

Table 46
The Number of Persons in the Sample from Beni Suef by Water Source and Use.

Water Source	Water Use				
	Drinking	Bathing	Laundry	Utensils	Animals
Piped inside	11	9	9	9	0
Piped outside	306	301	200	181	2
Hand pump inside	46	42	41	40	0
Hand pump outside	583	561	439	435	26
Canal	30	65	272	242	296

Table 47
The Percent Prevalence of *S. haematobium* by Source and Use of Water supply in the sample from Beni Suef.

Water Source	Water Use				
	Drinking	Bathing	Laundry	Utensils	Animals
Piped inside	10.5	9.7	15.4	9.7	NC_
Piped outside	21.4	21.0	19.1	19.3	NC
Hand pump inside	27.7	30.0	30.9	27.2	NC
Hand pump outside	30.6	31.0	29.0	28.5	NC
Canal	35.3	35.2	31.7	31.3	32.3

* No Cases.

for standpipes in Guzaria (2), and in Abu Rish (3), was also supplied by the treatment plants in Aswan. In Ga'afra, the water for standpipes was supplied by the water treatment plant in Daraw (see map, Figure 11). In Bimban (10), 75.4% of the homes had indoor hand pumps and 21.5% of the sample obtained their water from outdoor hand pumps. The remaining 3.9% were scattered between the canals and the drains. In the subsample from Bimban (10), domestic water was uniformly obtained from hand pumps inside the house.

The percentage of the sample with latrines are shown in Table 49. In the sample as a whole, 65.1% of the homes had latrines, an impressive figure for a rural underdeveloped area, of which the study sites at Aswan are a good example. The relationship between schistosome infection and the presence of a latrine was significantly lower (chi square, $p<0.01$) for those who had them in study sites 1 to 4. These results are also shown in Table 49.

Results of the Resettled Nubian Study

Selection of the Sample and Response

As mentioned, the villages selected for study were the same villages surveyed by Zawahry (1964) before the Nubians were relocated. In addition, data were also collected from two other villages, Tuskha (6) and Kalabsha (9). Summarized in Table 50 is the descriptive pattern of selection and response by study site. All those selected and requested to attend did so. The combined population of all the Nubian sites examined was 16,065 and the total number of persons examined was 3,275. Probability of selection varied from site to site as it did throughout the Downstream Study and ranged from 0.10 to 0.69. There were 493 who did not give a urine specimen and 2,782 who did, or 85% of the total.

Age-Sex Distribution of the Nubian Sample

The age-sex distribution of the Nubian sample as a whole and by site is given in Table 51. Figure 28 shows the proportional age curves by site for comparative purposes. The age and sex structure between sites was statistically significant (chi square, $p<0.01$). Typically, Nubia has had more females than males as is the case in this sample, but past data (Zawahry, 1964) suggests that males are in proportionately greater number than before.

Overall Prevalence of *S. haematobium* in the Nubian Sample

The number of persons in the sample passing *S. haematobium* in their urine or stool was 244, or 8.9% of the sample. After adjusting for the sampling fraction and

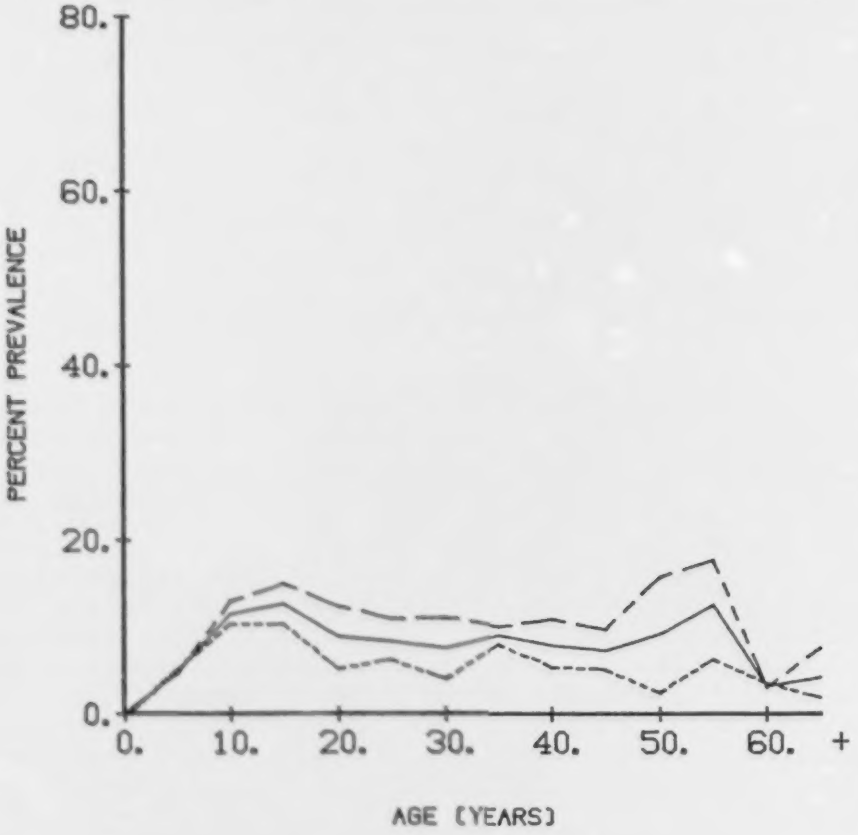

Figure 24. The adjusted age-sex prevalence distribution for infections with both species for all study sites in the Kafr El Sheikh study area. The long dash corresponds to males, the short dash to females, and the solid line for the total.

Table 48
The Number of Persons per
Standpipe by Study Site in Aswan.

Study Site Code	Number of Standpipes	Population	Persons per Standpipe	%Prevalence of *S. haematobium*
1	0	2371	0	6.9
2	8	4021	503	0.2
3	3	1915	638	4.2
4	55	4701	85	5.9
10	0	3076	0	22.1

age-sex differences between the five study sites the overall estimated prevalence was 7.2%. The prevalence of *S. haematobium* at each site varies significantly (chi square, $p<0.01$), although generally low in the Nubian sample as a whole, except for Kalabsha (9). These results are shown in Table 52. The suprisingly high prevalence in Kalabsha (9) seems to be atypical of this region, and the higher prevalence in females than males is unique to all study sites throughout. This aspect is further assessed in the following section. Figure 29 shows the age adjusted prevalence in the Nubian sample for *S. haematobium*. These results do not exclude the possibility of sporadic *S. mansoni* infections in any of the Upper Egypt study sites.

Environmental Aspects of New Nubia

The villages of New Nubia, built in 1963 by the Egyptian government in a attempt to compensate these people for the loss of their homes, are typical of expedient low cost "social" housing projects with each housing unit invariably constructed like the one before it. Therefore, environmental variation from village to village was minimal. All houses had been built with a latrine, and standpipes were present throughout the villages. Except for Kalabsha (9) and Daboud (not a study site), all the villages of new Nubia were located to the east of the Aswan-Cairo Motorway at the edge of the Kom Ombo agricultural plain in the desert, strategically located at a distance from the irrigation water courses. Treated water was supplied by a joint distribution system connected to both the water

Table 49
Percentage of Homes with Latrines and the Relationship to
Schistosomiasis Prevalence in the Aswan Study Sites.

Latrine	Number	Percentage	*S. haematobium*			
			Negative		Positive	
			#	%	#	%
Present	1392	65.1	1353	97.2	39	2.8
Absent	747	34.9	707	94.6	40	5.4*

*Chi Square, $p<0.01$

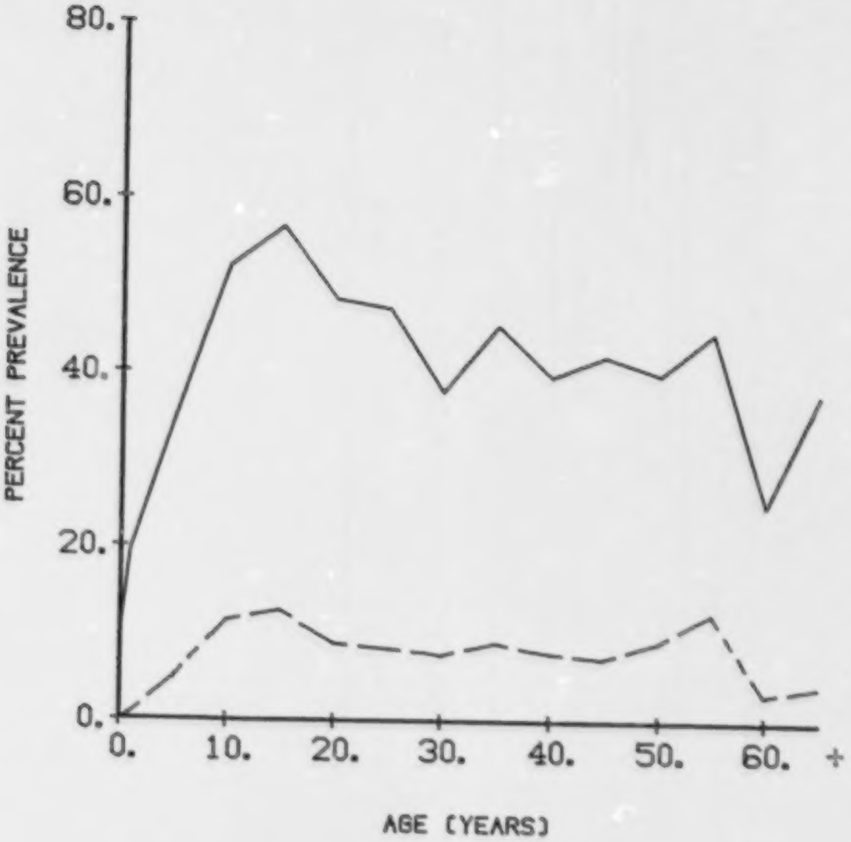

Figure 25. The adjusted age prevalence distribution for those infected with both species (dash line) and for those infected with either or both species (solid line).

Table 50
The Pattern of Selection and
Response in the Nubian Sample

Village Name	Study Site Code	Number Persons Examined	Number Families Examined	Number Not Giving A Urine Specimen	Number Persons Selected and Not Attending	Number of Houses Examined	Population
Ballana	5	288	202	253	0	201	8055
Tuskha	6	819	201	171	0	220	3541
El Malki	7	622	707	25	0	200	1950
Kurta	8	510	226	149	0	200	735
Kalabsha	9	623	200	13	0	200	1794
Total		3362	1036	611	0	1021	16065

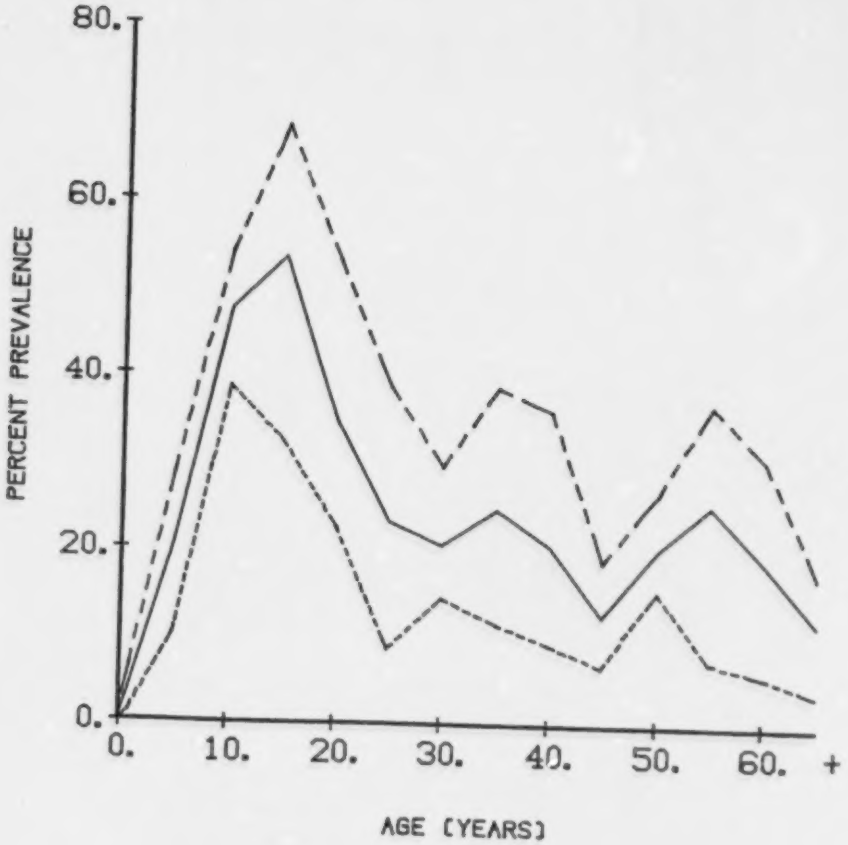

Figure 26. The adjusted age-sex prevalence distribution for *S. haematobium* infections in the study sites from the Beni Suef study area. The long dash corresponds to males, the short dash to females, and the solid line for the total.

Table 51
The Number Examined and the Percent Positive
by Age and Sex for S. *haematobium* in the Nubian Sample.

Age Group	Infected with S. *haematobium*					
	Males		Females		Total	
	# Examined	%	# Examined	%	# Examined	%
0<1	14	0.0	6	0.0	20	0.0
1-4	126	1.6	130	1.5	256	1.6
5-9	164	4.9	186	8.1	350	6.6
10-14	179	14.0	159	3.8	338	9.7
15-19	145	18.6	181	9.4	326	13.5
20-24	60	31.7	119	10.1	179	17.3
25-29	47	21.3	109	13.8	156	16.0
30-34	44	18.2	97	8.2	141	11.3
35-39	37	16.2	122	5.7	159	8.2
40-44	8	17.8	98	9.2	143	11.9
45-49	54	7.4	95	8.4	149	8.1
50-54	44	9.1	75	8.0	119	8.4
55-59	44	11.4	91	4.4	135	6.7
60-64	42	2.4	54	1.9	96	2.1
65 +	75	1.3	112	4.5	182	3.2
Total	1120	11.4	1634	7.0	2754	8.9

treatment plants in Daraw and in Kom Ombo. Villages at the extreme end of this distribution system suffered intermittent water supply due to excessive demand, especially in the hot dry summer months. El Malki (7), Kurta (8), and Kalabsha (9) were all limited to a few hours a day when the water pressure in the system was sufficient to reach these villages. All villages in new Nubia have electricity, a benefit of the AHD.

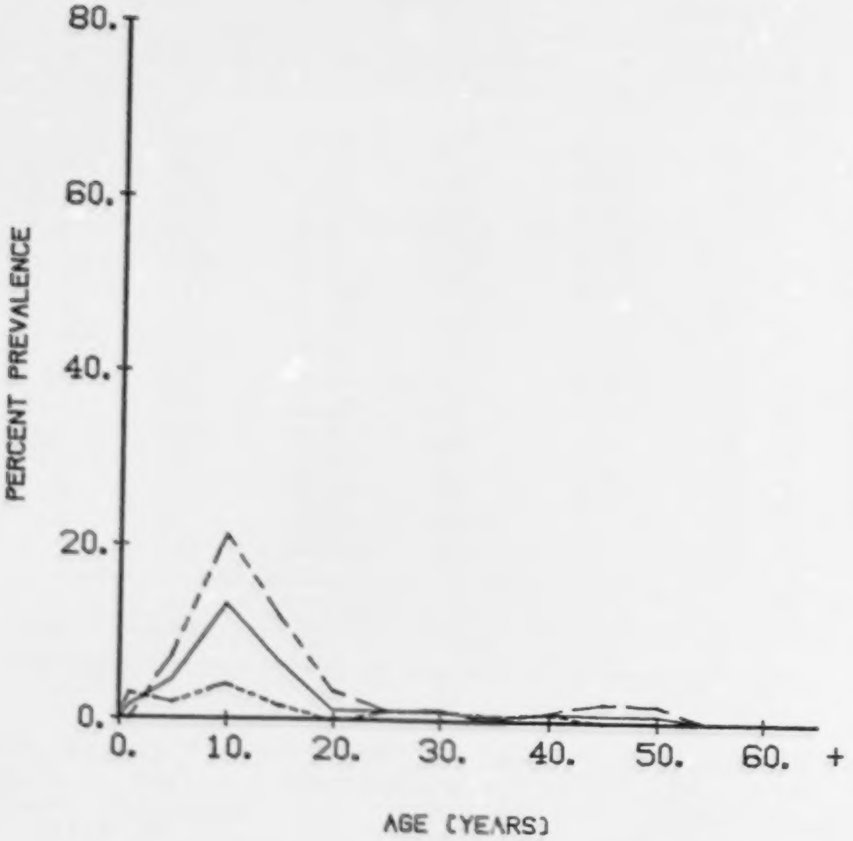

Figure 27. The adjusted age-sex distribution for S. *haematobium* infections in the study sites from Aswan study area. The results from Bimban (10) are not included. The long dash corresponds to males, the short dash to females, and the solid line for the total.

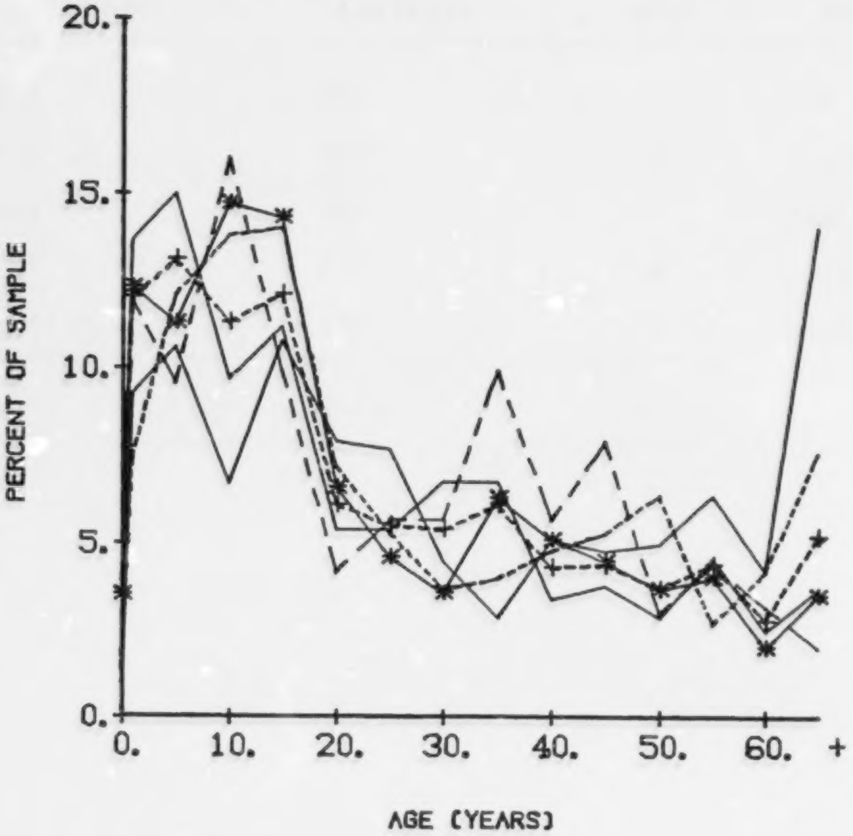

Figure 28. The age distribution by study site in the Nubian sample. Each line represents a study site. The abnormally high percentage of persons in the sixty and over age groups was found in Kurta (8), represented by the solid line. It reflects the excessive outward migration by younger groups.

Table 52
The Percent Prevalence of *S. haematobium* in the Nubian Sample by Study Site

Study Site Name	Study Site Code	Infection with *S. haematobium* Number Examined	 Percent Positive
Ballana	5	535	5.8
Tuskha	6	649	3.7
El Malki	7	597	2.0
Kurta	8	461	1.7
Kalabsha	9	512	32.8
Total		2754	8.8

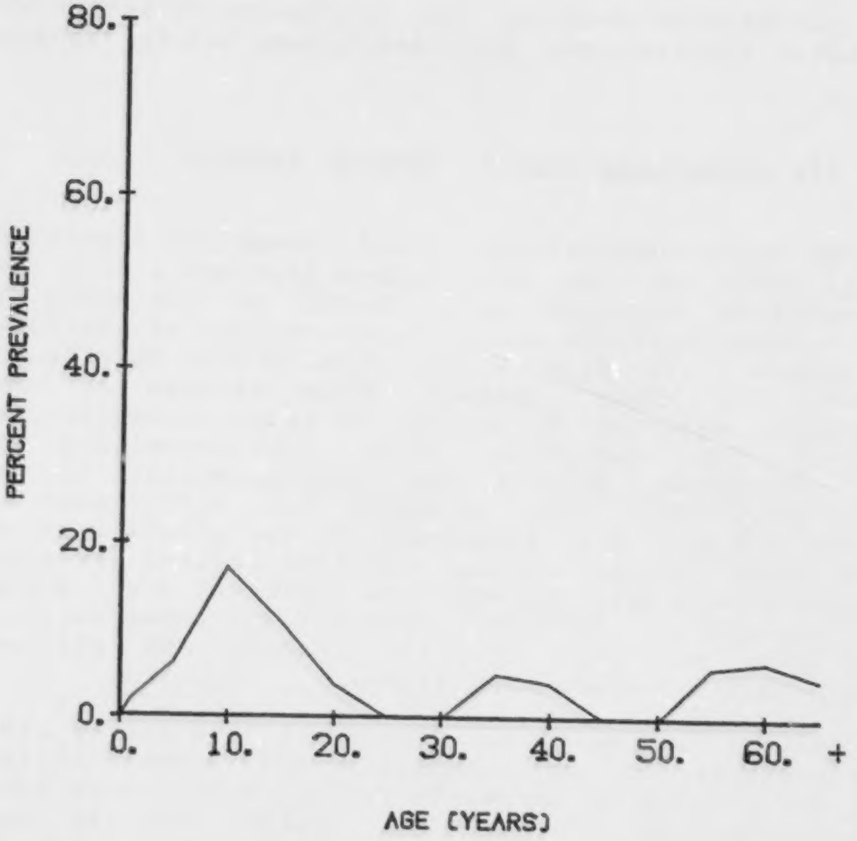

Figure 29. The adjusted age prevalence distribution for S. haematobium infections in the Nubian sample.

CHAPTER V

DISCUSSION AND CONCLUSIONS

Like the Results section, the discussion is presented under two major subheadings: the downstream and the Nubian studies.

The Downstream Study: General Aspects

A large scale country-wide field survey was completed in the rural areas of the Nile Valley downstream from the AHD. Thirty-three villages were chosen on the basis of typicality to represent the three major regions of the Nile Valley in Egypt: the Nile Delta, Upper-Middle Egypt, and Upper Egypt. In these village sites members of the population were selected according to known probabilities and examined for infection with schistosomiasis as described. Prevalence figures for schistosomiasis in the respective areas have been adjusted for differences in sampling fraction and age structure of the populations at the various study sites. (Only adjusted figures are used when comparisons are made between the different study areas or between the results of this research and other works.) Data were also obtained on the housing and village environments of the sampled population.

The general aspects of the results of this survey show that the prevalence of schistosomiasis is highest in the rural villages sampled in the north central delta where both species of schistosome are present. Aside from the long term intensive perennial irrigation in the delta which no doubt has contributed to the high overall prevalence, the increased risk of acquiring either species is another reason that the prevalence of schistosomiasis is elevated. If all those who were infected with one species were invariably infected with the other there would be only an increase in morbidity rather than in prevalence. However, the results show that infection with either or both species of schistosome is over five times more prevalent than infection with both species. This large difference in prevalence shows that transmission of the two species is occurring to a great degree at separate sites.

Farooq (1966) has also observed that transmission of the two species depends on separate sites. Main drains and canals were found to play a more significant role in the transmission of *S. haematobium*, whereas distributaries, (smaller canals used to distribute the water to the field channels) were more important for *S. mansoni* transmission.

The prevalence of both infections and of schistosomiasis varied dramatically from one site to another, reconfirming that schistosomiasis in Egypt is focally distributed. Scott (1937), Farooq, *et al.* (1966), and others have also noted this aspect. This was also true for the study sites in Beni Suef and in Aswan. The interesting correlation between the prevalence of *S. haematobium* and *S. mansoni* by site in Kafr El Sheikh in this study, suggesting that conditions good for the transmission of one species are favorable for the other, have not been observed before. It is not known whether this relationship is true in other sectors of the Nile Delta where prevalence of the two species is at an overall different level or not. It is possible that if good conditions for *S. mansoni* transmission exist then they are also favorable for *S. haematobium*, but not vice versa. It is significant that the prevalence of *S. mansoni* infections was invariably lower than *S. haematobium* infections regardless of the study site picked. This is consistent with findings of past surveys in the Nile Delta.

The age-sex distribution of *S. haematobium* was typically higher in males than females and highest in the younger age groups. *S. mansoni* infections did not follow as closely the typical age-related distribution, remaining high in the adults rather than dropping in prevalence like the *S. haematobium* infections. A number of hypotheses have been formulated to explain the age-related differences for both species (Farooq, *et al.* 1966), but the lack of a higher prevalence in the adolescent years for *S. mansoni* requires further explanation. Two possibilities are suggested. First, it is possible that the age distribution of *S. mansoni* seen in the study sites is being altered due to spontaneous changes in the ecology of the disease and its transmission. Evidence is now available to show that changes in prevalence have been occurring in this area over a rather long term as discussed in the Review of Literature. Second, locally implemented control programs are often directed at the groups with the highest prevalence, i.e., the youth. School health programs designed to detect and treat the enrollees for schistosomiasis are required by law and are carried out with varying degrees of efficiency. It is possible that these and other control measures have had some success, thus depressing the peak of prevalence usually seen in these age groups. However, the age prevalence curve for *S. haematobium* was not depressed in the young age groups, as would be expected if control measures were working. Studies in Beheira by Farooq and Hairston (1966) showed that the incidence rates for *S. haematobium* were almost three times as high as those for *S. mansoni*. Although this explanation is the more unlikely of the two, it is possible that some of the *S. haematobium* infections were cured but quickly reacquired.

South of the Nile Delta in the study sites selected in the Beni Suef area, the adjusted prevalence of *S. haematobium* was a few points below that of the delta sites in Kafr El Sheikh, 26.7% as compared to 30.0%. The age-sex prevalence followed a typical distribution in these study sites. When only males are compared, the results from Beni Suef show, interestingly enough, that this area was higher in prevalence. The prevalence for males in Beni Suef is 37.0% and in Kafr El Sheikh only 35.2%. Obviously the prevalence of *S. haematobium* in females was much lower in Beni Suef. Indeed, the difference in the distribution of *S. haematobium* prevalence between the sexes is much greater in Beni Suef, almost twice that in the delta sites. In the villages studied in Aswan, the differences in prevalence between sexes were was again greater, by two times. This sex related differential seems to increase from north to south, as the prevalence of the disease decreases. This unique observation has a number of implications concerning control strategies.

In the Aswan study sites, except for Bimban (10), prevalence of *S. haematobium* was remarkably low. The overall adjusted prevalence was only 4.1%. As just pointed out, the difference in prevalence between the sexes was the greatest here of all the study areas, and there was significant variation of prevalence between study sites. The prevalence of *S. haematobium* in Guzaiera (2) was the lowest recorded (0.2%) in any of the downstream villages studied. Many of the villagers from the Guzaiera (2) site were employed in occupations other than agriculture and many worked in the city of Aswan which is only a few kilometers away to the south. Equally important, and typical of other villages with low prevalence in this study area, Guzaiera (2) is located on high, dry, barren ground outside of the narrow strip of cultivated land that lies along the Nile. Continuing north from here, the Nile Valley is very narrow, widening gradually as it passes through the next two governorates, Qena and Sohag (see map, Figure 10). Only in the Kom Ombo plain does the valley widen to any extent. North of this plain the valley returns to the narrow confines typical of the region. Land available for cultivation is scarce throughout the Aswan governorate, except in Kom Ombo, and the local villagers have wisely not built on land that could be used for growing crops. In the study sites located north of the city of Aswan and south of the Kom Ombo plain, the villagers live at a greater distance from the irrigation canals than do the villagers located in the delta or in Upper-Middle Egypt. In the delta or in Upper-Middle Egypt villages are built in and are surrounded by cropped land. In addition to being isolated from the irrigated land, many of the villages of the Aswan region are supplied with treated water, as was pointed out in the Results.

Villages are found within the cropped areas with increasing frequency as one travels north out of Aswan into the Qena and Sohag governorates. North of Sohag only a small fraction of the rural population resides in villages located outside the cultivated land, and these villages are often bounded on one side by their fields. For convenience, "desert village" has been defined as one located on dry, unvegetated, barren ground; and a "non-desert village" is a village in and surrounded by irrigated productive land. In order to have some measure of prevalence in an non-desert village, Bimban (10), on the west bank of the Nile in the Kom Ombo plain, was surveyed. Sugarcane is cultivated here and thick stands of date palms are common. Water for domestic purposes is either piped from a deep well, pumped by hand from shallow wells, or taken directly from the nearby canals. In this village 24.3% of a subsample were positive for S. haematobium. Although these results are based on a more limited sample than usual in this village area, it is a strong indication that schistosomiasis prevalence is considerably higher in the non-desert type of village. This new evidence suggests that prevalence between villages can vary greatly, certainly more than what has been seen in the northern areas of Beni Suef and Kafr El Sheikh. This is most likely true of Upper Egypt in general where both these types of villages are common. It is important that future prevalence surveys in Upper Egypt take into consideration the types of villages selected for study. Differences in water supply of selected villages (discussed below) and differences in location, whether in the desert or in the cultivated land, suggest very different rates of transmission.

In light of this finding, past studies done in Upper Egypt now must be reexamined in order to determine if the villages sampled were "desert type", "non-desert type", or a combination of both. In turn, it is necessary to determine the exact distribution of the rural population between these two village types in Upper Egypt so that results from these areas can be appropriately weighted. Without this information, which unfortunately is not currently available, prevalence figures cannot be readily applied to the general area. Ideally, samples in future surveys should be selected to be representative of the distribution of the total population among the various village types.

Water Supply and Schistosomiasis

Egypt has had a progressive program for the installation of publicly accessible protected water supplies since the early 1950's. Of all the villages sampled in either the downstream or Nubian study, only in Kazan Sharq (1) were protected sources of water totally absent. Now standpipes are present throughout the village, supplied by the new Aswan Water Treatment Plant. Barout (15) and Bimban (10) were the only other villages which did not have standpipes and depended heavily on water from shallow wells where hand pumps had been installed.

When available, protected sources of water, either from standpipes or from hand pumps, were preferred for drinking over unprotected sources and were used heavily (see Tables 41, 45). However, these sources seemed to be inadequate for other uses in Upper-Middle Egypt and in the Nile Delta where activities such as bathing, laundry, etc. were still frequently carried out in the canals. In particular, water use for animal care and cleaning, in most cases, involves exposure to highly contaminated sources. The Egyptian felaheen take pride in keeping their livestock clean, especially the domestic water buffalo, common throughout Egypt. Water buffalo require frequent dips. According to Farooq et al. (1966) this is not an activity done solely by adult men but involves both sexes, including the younger age groups. It would seem that alternatives to the unprotected canals as water sources for animal care would be difficult to formulate. This must be kept in mind as a water-related behavior with a high potential for exposure to schistosome infection even when protected public supplies are readily available.

It has been shown in this study and in others (Farooq, et al. 1966a; Unrau, 1975) that protected water supplys strongly influence the prevalence of schistosomiasis. The prevalence of both species of schistosomes in the Nile Delta was shown to be related to the quality of the water source. A gradient of improvement in prevalence was seen as the quality of the water source improved. This was very dramatic in the sample sites of Upper-Middle Egypt where there were more possibilities for different sources of domestic water. In Upper Egypt protected sources were utilized even more intensively for most water-related activities. Infection in Upper Egypt (excluding Bimban (10)) with schistosomes, although much less than in the other areas, is probably being acquired during the period when the domestic animals are being washed. In the region of the Aswan study sites, this activity invariably takes place in the Nile itself, and, like most large streams, the river is an inefficient site for transmission.

Distribution of *S. mansoni* and the AHD

Recent studies (Almy and Cline, 1977) have indicated that the distribution of *S. mansoni* is changing in the southern-most areas of the Nile Delta, and that this may be a result of controlling the Nile's discharge by the AHD. Furthermore, there has been speculation that *S. mansoni* infections have already invaded areas south of the Nile Delta. The hypothesis is that the annual flood had restricted the *Biomphalaria* species to the calmer waters of the canals and drains of the lower Nile Delta, whereas the less delicate *Bulinus* group was able to establish itself throughout the country. While this is a widely held belief, there is no evidence to show that the ecology of *Biomphalaria* is solely dependent on water discharge or velocity. The concern, however, is well founded in that the spread of *S. mansoni* infections to new areas is a serious threat if the prevalence patterns of the Nile Delta are any indication of what would happen if this snail species did indeed expand its territory.

In Beni Suef, twenty persons were positive for *S. mansoni* in their stool specimens, less than one percent of the sample. Whether or not this indicates that *S. mansoni* has established a focus of infection south of the delta remains to be confirmed. The presence of the snail host, *Biomphalaria*, has not been investigated. Furthermore, it cannot be stated for certain that those infected have acquired the *S. mansoni* parasites in the Beni Suef area or in the north during trips to the delta. Thirteen persons were detected with *S. mansoni* infections in 1972 (Hussein, 1972), in the same study sites. If these infections were acquired in Beni Suef then there is reason to believe that *S. mansoni* infections could be found thoughout Upper-Middle and Upper Egypt. Indeed, *S. mansoni* infections have been reported to be very prevalent (60%) south of Egypt in the Gezira irrigated area of the Sudan (Webbe, 1972) and are found consistently throughout the remaining southern portions of the Nile river basin. From this prepective it would seem reasonalbe that *S. mansoni* infections would have always been distributed along the entire length of the river valley. However, no one has yet explained the limited distribution of *S. mansoni* infection in the Nile Delta that has been seen in the past. Scott (1937) was intrigued by the sharp demarcation which divided the regions of the delta into areas of high and low infestation with *S. mansoni*. He could not find any noticeable change in the topography or in the systems of irrigation between these areas. Nor could a reason be found based on the type of crop grown in these respective regions. He concluded that there was some controlling human factor that would account for the sharp difference seen, although the areas in question seemed demographically homogeneous to each other. The point is that any S. mansoni infections detected in areas south of the delta, can not be explained totally by changes in hydrology. A fuller understanding of the life cycle and biology of the parasite is necessary before conclusions can be drawn about how the construction of the AHD may be affecting the distribution and transmission of S. mansoni. However, the possibility of sporadic cases in Upper-Middle and Upper Egypt remains and must be investigated.

General Estimates of Schistosomiasis

It is very desirable to use the findings from the three different areas (four including Nubia) for which prevalence figures for schistosomiasis have been obtained to calculate estimates of prevalence for the general rural population. This must be carefully approached for several reasons.

One, the technique most commonly used in the past and employed in this study, i.e., the presence of characteristic ova in the excreta, is insensitive, with unknown numbers examined and classified as negative who are in fact positive. Weir, et al. (1952) showed long ago that time-consuming and elaborate methods must be employed before an individual can be confirmed free of schistosoma infection. Any findings based on ova detection in the excreta have to be interpreted as underestimates. Furthermore, there has not been the necessary experimental work to show exactly how underestimated these prevalence figures would be. The findings of Weir et al. (1952) suggested that as many as 88% of those negative for ova in the urine on one examination could be shown to be positive by examining rectal snips. Therefore, any survey using detection of ova in the excreta as a method of prevalence determination cannot provide an exact number of all those infected. Nevertheless, results based on these methods continue to be presented, partly because of the practical ease with which data can be obtained and also because data based on ova detection are very useful for developing trends over time, demonstrating differences in relative intensity of infection from one location to another, and monitoring control programs. In addition, the usefulness of results based on ova detection in the excreta can be increased by

(1) determining the number of ova in a given amount of excreta and thus providing a measure of intensity of infection in the individual, and

(2) by designing an ova detection survey to show incidence (i.e., the number of new infections occurring in a given period). Incidence determination is the only direct method of

revealing changes in transmission.

Two, the total rural populations of the three geographic areas are very different. For example, the rural population of Upper Egypt is only 17% of the total rural population. This means that any estimate for a given area will have to be appropriately weighted according to the proportion that the area's rural population contributes to the total. These figures are available from CAPMAS (1976).

Three, the age-sex structure between the different areas must be controlled for if accurate estimates are to be made. Age-sex information is only available for 1960 and no later. Since the population has not been stable but rather growing rapidly (approximately 2.1 to 2.5% per annum) the proportion of the younger age groups has no doubt been increasing, and it is in these very age groups that prevalence is highest. However, a quick glance at the age-specific distribution between the different study areas (seen in Figures 15, 16, 17) would indicate that the age structures of the rural populations are remarkably similar.

Four, an assumption must be made that the environmental health conditions are more or less the same throughout a given area for which estimates are to be made. Especially important are the types of water supply and agricultural practices in relation to village type, the two environmental parameters shown in this study to be most closely linked to schistosomiasis prevalence.

Collectively, some very broad assumptions must be made in calculating estimates from the study sites to be applied to the general rural population. The results of the examination for ova indicate only the minimum number infected which will be an underestimate. The rural population of each area has been obtained from CAPMAS (1976) which is the most acceptable demographic data available, but does not provide age-sex distributions in the population. In the delta and Upper-Middle Egypt an assumption is made that the population structure and environmental conditions are similar throughout the respective areas, with the exception of the Fayoum in Upper-Middle Egypt, which must be excluded due to the ongoing schistosomiasis control program. However, this assumption is more difficult to apply in the Aswan area where environmental conditions and the prevalence of schistosomiasis vary widely. Before estimates can be calculated in this area, the distribution of the population between the "desert" and "non-desert" type villages should be known. As mentioned, this demographic information has never been compiled. Without this knowledge, it is difficult to choose between either "desert" or "non-desert" for a representative estimate of prevalence for this area of Egypt, because it is not known how much of the population is distributed in "desert" villages where prevalence is low.

Assuming that the prevalence in the subsample at Bimban (10) is the true prevalence of the "non-desert" villages of all Upper Egypt, then, at the risk of over-estimating the prevalence for this area, the proportion positive in the Bimban (10) subsample is used for calculating the number of infected in this area.

With the above assumptions and limitations foremost in mind and relying on a quote from Moser and Kalton (1972) that says "The accumulated insight of an experienced worker frequently merits recording even when absolute documentation cannot be given", estimates have been calculated and are shown in Table 53. Almost 6.9 million rural Egyptians were estimated to be infected. No doubt this is an underestimate, and actually it is only an approximation for which a statement of statistical precision cannot be calculated. Underestimation also results from not knowing how many are infected in the urban areas where transmission is nil, but to which large numbers of the rural population, who presumably carry with them a measure of infection, have been migrating.

Table 53
Estimated Prevalences for the Different Downstream Study Areas Based on Special Assumptions stated in the text.

Area	Rural Population 1976*	Estimated Prevalence of Schistosomiasis	Estimated Number Infected
Nile Delta	11,635,949	0.420	4,887,099
Upper-Middle Egypt (minus the Fayoum)	4,772,647	0.267	1,274,297
Upper Egypt	3,224,260	0.227	731,907
Total	19,582,856	0.352	6,893,303

* CAPMAS (1976).

Farooq, et al. (1966) and Scott (1937) both increased their estimates based on corrections for more than one examination for schistosome ova. These corrections would increase this approximation of overall prevalence from 0.352 to 0.415. Either prevalence figure, corrected or uncorrected for false negatives, seems high with regard to the lower prevalence figure noted in Upper-Middle and Upper Egypt. This is because 59.2% of the rural population lives in the Nile Delta where schistosomiasis prevalence has always been most intense.

Secular Trends in Schistosomiasis

In the Review of Literature, all available past data on the distribution and prevalence of schistosomiasis in Egypt were presented and assessed for methodological accuracy and comparability. Whereas it would be desirable that more information, especially recent data, was available, a surprising amount of useful information was found. Past data are employed in this section to:

1) determine the general direction of prevalence trends since the 1930's in the rural population downstream from the AHD, and

2) use these trends to assess the impact of the impoundment of the Nile on schistosomiasis prevalence. It has been noted that there has been widespread speculation that the prevalence of schistosomiasis has been rapidly increasing as a direct result of the construction of the AHD.

The earliest data from the last century and from the early part of this century, collected mostly from hospital outpatient clinics in the northern sectors of the Nile Valley were uniformly high and suggested that infections were frequent and widespread. These prevalence figures are unreliable due to selection biases in the sample. Evidence did show that *S. mansoni* infections were rare outside of the Nile Delta. Scott"s work (1937) offers the first analytical insight into the prevalence and distribution of schistosomiasis, and his data are used here as a baseline to which all survey data collected since that time are compared.

Long term or secular trends require comparisons between Scott's (1937) studies and more recent observations, and to maximize these comparisons over time, tabulations were made separately for each of the three major geographical regions of Egypt which have been described. The results of this study and others confirm that environmental and age-sex related variables strongly influence the prevalence of infection. Significant changes in these independent variables have been noticed to occur with greater variation between the three major areas than between different villages within an area, and when general estimates are made, these aspects must be born in mind.

Table 54
Nile Delta: Percent Prevalence of
Schistosomiasis for Selected Years.

Year	Percent Prevalence		
	S. haematobium	*S. mansoni*	Schistosomiasis
1937 (Scott)	53	54	83
1955 (EMPH)	46	31	ND
1966 (Farooq, *et al.*)	30	29	41*
1976 Kafr El Sheikh	30	20	42

*Schistosomiasis figure for either type of infection.

Table 54 shows the overall prevalence for *S. haematobium*, *S. mansoni*, and schistosomiasis in the governorate of Beheira between the years of 1937 and 1966. The data from Scott (1937) and from the EMPH study (1955) are estimates averaged from eight widely spaced locations in this governorate. The overall prevalence (adjusted for sampling fraction and age structure) from the Kafr El Sheikh study villages, dated 1976 (the year of the field survey) was also included as an approximation of current information for the Beheira area. Results from Kafr El Sheikh may not be truly representative of the conditions in Beheira in that *S. mansoni* prevalence has always been slightly higher in the Beheira governorate. Therefore, the prevalence of *S. mansoni* (20.0%) in Kafr El Sheikh may be a slight underestimation of the true prevalence and in turn would affect the estimate of those with schistosomiasis. Otherwise, to quote Farooq, *et al.* (1966a), "Living conditions in the rural and control divisions (in Beheira) do not differ markedly from those observed in other parts of rural Egypt both recently (Zaghloul, 1963) and about a generation ago, (Headlee, 1933)", these two governorates are in many respects quite similar. Still it could be argued that too many factors are not controlled for to make precise comparisons between these studies. Particularly sensitive is the question of differences in methodology employed by the respective investigations. The EMPH(1955) study was in fact designed after Scott's (1937) work and was implemented in an attempt to establish a long range plan for routine surveillance, which unfortunately has not been continued. Methodologies used in the study headed by Farooq, and Nielsen, (1966) and used in this study are in essence also very alike. While no quantitative evaluations of the different laboratory techniques used are available, the basic approach employed by all of these investigations, i.e. the examination of urine or stool sediment for characteristic ova, adhere to similar basic methodological principles. In addition, the techniques for identification of schistosome ova are not sophisticated, delicate, or, for that matter, sensitive, procedures. The schistosome ova are large, averaging 145 microns in length, and are in no way difficult to speciate or to distinguish from other parasitic ova or cysts, or detritus. However, it is possible that qualitative differences could be found even between two laboratories using the same procedures. Also, the focal nature of the disease indicates that other different yet valid estimates could be easily obtained by sampling different villages. In face of these limitations the evidence of this and previous studies remains overwhelmingly convincing. There is not one example in four completely independent observations, made over a span of 39 years in the Nile Delta, to indicate an increase in the prevalence of _either_ species. Instead, there appears to have been a longterm downward trend in schistosomiasis prevalence, over the past four decades, perhaps tapering off somewhat in the last ten years.

Table 55 shows the overall prevalence of _S. haematobium_ in Upper-Middle Egypt in the governorates of Beni Suef for 1937, 1955, and 1976, and in 1968 for the governorate of Minya. The same assumptions and limitations apply to these observations from Upper-Middle Egypt as were stated for the Nile Delta, but in this region the downward trend is even more marked. The prevalence of schistosomiasis has dropped from 82% in 1937 to 27% in 1976. Again the evidence is clear and convincing, i.e., there is strong evidence of a decrease and certainly no indication of an increase in prevalence in Upper-Middle Egypt since 1937.

In the remaining area, Upper Egypt, the situation is not as clear cut. Although speculations concerning the effect of the AHD on schistosomiasis were most often sweeping statements such as those made by Van der Schalie (1974), Fogel, _et al._ (1970), and Furnir (1975), more specific predictions were made by Farooq (1967). The evidence already stated does not support the generalized and completely unfounded statements such as "schistosomiasis is more prevalent now than ten years ago" (Furnir, 1975), but Farooq's 1967 statement that 2.65 million new cases would result in areas to be converted to perennial irrigation requires a closer look.

Table 55
Upper-Middle Egypt
Percent Prevalence of *S. haematobium* by Selected Years.

Year	Percent Prevalence
1937 (Scott)	82
1955 (EMPH)	36
1968 (Hamman, *et al.*)	35
1976 BeniSuef	27

Although Farooq (1967) did not specify the area that was to be converted to perennial irrigation it can safely be assumed that he was referring to Upper Egypt, as by 1967 all other areas in Egypt had long since been using perennial irrigation schemes. According to the rural population figures from CAPMAS (1976) shown in Table 52, there are 3.2 million rural inhabitants in Upper Egypt. In essence this is the population at risk. Farooq (1967) indicated that before the AHD was built the overall prevalence in this population was 5%.

First, there is good evidence that the prevalence of schistosomiasis was already rising in Upper Egypt long before the AHD period. By 1955 the prevalence of schistosomiasis in the rural population of Sohag, where 47% of the total population of Upper Egypt resides, had risen from 3% to 42%, and in Aswan the prevalence had also risen, in this case to 23% (Wright, 1973). After 1955, the prevalence had remained low (4%) only in Qena. There is no information on prevalence for Upper Egypt between 1955 and when the AHD was built. It is doubtful, however, that the prevalence remained low throughout this period, as it is fairly certain that pumps (the floating variety mentioned earlier) and canals were installed previous to the major schemes implemented after the AHD.

Farooq's (1967) estimate of 2.65 million new cases translates to 82% of the total rural population of Upper Egypt. While it is possible that increases in prevalence occurred in limited areas of Upper Egypt as a result of the irrigation expansion related to the AHD construction, it is doubtful that 82% of this population is positive for schistosome ova. Current, but rather limited, information on prevalence in Upper Egypt does not support this prediction. Dazo and Biles (1972) found an overall prevalence of 38% in their sample from Upper Egypt, but as pointed out these figures are biased because of self-selection, which, incidentally, usually tends to elevate prevalence estimates. At any rate they did not find even half the number infected that was projected by Farooq (1967). The current prevalence figures used for general estimates in Upper Egypt collected by this study are from the Bimban (10) subsample. For reasons already discussed, the Bimban (10) subsample was used as a figure for estimating prevalence in this region. This figure is also lower, by almost four times, than Farooq's (1967) predictions. Admittedly, the current information on prevalence in Upper Egypt is not extensive, but it is difficult to imagine that the environmental conditions and prevalence of schistosomiasis in Upper Egypt are now what they were in the Nile Delta and Upper-Middle Egypt 40 years ago. In this same vein it is interesting that in 1937 Khalil and Azim (1937), during their original work on the effects of irrigation on schistosomiasis transmission, noted an increase in prevalence in Bimban (10) which had also been included in their studies, from 2% to 64% (see Table 1). It would seem that, in Bimban (10) at least, there was a burst of infection following conversion of the area to perennial irrigation. Since that time, more current data from this study suggest that the prevalence has fallen to almost a third of what it was 39 years before.

The Kom Ombo plain was the first site in the whole of Upper Egypt to be converted to perennial irrigation and was a focus of high prevalence in an area that was predominantly low during the 1930's. It is hypothesized here that following conversion of a given area in Upper Egypt to perennial irrigation, regardless of the specific type of scheme used, there was a sharp rise in the prevalence of schistosomiasis, followed by a tapering off, most likely in the 1960's or 1970's, similar to the other sectors of the Nile Valley to the north. Furthermore, the prevalence in Upper Egypt at the time of the survey, in the agricultural villages, is at about the same level as seen currently in Upper-Middle Egypt, but future surveillance studies are needed to confirm this. It should be noted that prevalence information has been badly needed in this area of Egypt for a long time. It is because of the systematic exclusion of Upper Egypt in field studies in the past three decades that the exact developments, in terms of changes in prevalences and the causative role that the AHD complex has played, cannot be completely elucidated. However, the greater body of evidence does not support the many predictions that the high prevalence of schistosomiasis in Egypt, and indeed it is still very high, is the result of the formation of Lake Nasser and the related irrigation expansions. Rather, the AHD seems to have had a limited role, if any, over the past 12 years in increasing the prevalence of schistosomiasis.

If there were related increases they were limited to selected areas of Upper Egypt, with undetectable effects on the northern sectors of the Nile Valley in Egypt.

The first hypothesis of this study is rejected. Evidence obtained from the downstream study sites and from the historical data strongly indicate an overall decrease in the prevalence of schistosomiasis. The hypothesis that there have been overall increases in prevalence of schistosomiasis, in the downstream rural population, cannot be supported.

In concluding, it should be understood that there remains a potential for the spread of schistosomiasis, especially into the future reclamation areas and in the new lake. The lake has formed a huge new habitat favorable to snail vector proliferation. According to a number of trips made to the lake (Dazo and Biles, 1971, 1972; Scott and Chu, 1974) the species Bulinus, the vector for S. haematobium, has been found throughout. These aspects pose future potential problems for which frequent and tight surveillance is strongly recommended as a measure to recognize early changes.

Population Changes and Schistosomiasis

When the prevalence rates for Egypt cited in this study are used to show trends, the impact of population growth on the total number of cases of schistosomiasis is revealed. Because of the increase in population, the actual number of cases can increase without a change in prevalence or a change in the geographical distribution of the disease. This is an additional dimension of the impact of the disease and can be illustrated as follows:

In 1937, Scott (1937) estimated that 7.15 million persons in all of Egypt were infected with either one or both species of Schistosoma. (This included 0.5 million persons infected in urban areas. When they are excluded the estimate falls to 6.65 million cases.) The population at that time was 15.23 million persons, making the prevalence 46.95% (see Table 56). If we assume that there has been no change in prevalence since Scott's (1937) time nor any change in distribution, then 46.95% of the present population would be infected; that is, 17.95 million infected out of 38.23 million in Egypt in 1976. The difference would be 10.7 million more cases of schistosomiasis when compared with the number infected in 1935, a result directly related to a rapidly growing population.

If we assume that there has been a change in

Table 56
Table Showing the Results of Certain Assumptions Made on the Prevalence of Schistosomiasis in Respect to Population Changes in Egypt.

Area and Year	Population (1X10⁶)	Number Shedding Ova (1X10⁶)	Percent Prevalence
1935 Entire Nile Valley and Delta	15.23	7.15	46.95
1976 Entire Nile Valley and Delta	38.23	17.95	46.95
1976 Assyut to Aswan Only	4.27	2.0	46.95
1976 "Adjusted" Entire Nile Valley and Delta	38.23	19.95	52.18
1976 All Rural Egypt	19.58	7.13	25.9

distribution in the area south of Assyut to Aswan, where the prevalence in 1935 was in the neighborhood of 1-2%, then there are even more cases that would have to be added to the current "estimated" 17.95 million infected. As pointed out, there is good reason to think that S. haematobium has invaded this southern area of Egypt, as the land there is now under perennial irrigation. (Sporadic S. mansoni infections would not make a significant contribution to the overall prevalence.) Currently, there are 4.25 million persons living in this area between Assyut and Aswan, and if the overall figure of 46.95% is used to estimate the number of those infected, then the number of cases will equal about 2 million. That would raise the total cases from 17.95 to 19.95 or 20 million cases in 1976. When compared to the figures for the 1930's it would be a staggering 12.7 million more cases than the 7.15 million estimated in 1937.

However, there is no evidence that the prevalence has been maintained at the levels seen by Scott (1937) in the 1930's. There are no data in this study that would indicate an overall increase in prevalence. Instead, the many surveys that have been cited overwhelmingly point to a decrease. In addition, prevalence in the Fayoum is reportedly low at 8.1%, and there is an undetermined number in Upper Egypt living in "desert" villages where prevalence is also low.

It must also be remembered that prevalence estimates for Egypt are based on findings in rural areas and that very limited information is available for urban populations. This is important because the urban populations have been growing rapidly, at more than twice the rate of the rural areas of Egypt, and in the urban areas transmission is nil. In 1935, 77% of the total population in the Nile Valley and Delta was rural. Now it is just over 53% or about 20.44 million persons. At least 36.5% of this rural population (not including the Fayoum population) would have to be shedding ova to equal Scott's (1937) estimates in 1937.

This, of course, is very near the correct approximated prevalence calculated by this study for the rural population in the Nile Valley. The combination of declining prevalence, rural-urban immigration, and increasing population in the last 40 years has resulted, at least in the rural areas, in keeping the number of cases of schistosomiasis constant. From the urban perspective, an observer that has been seeing tens of thousands of new schistosomiasis cases (as rural-urban immigrants) has probably blamed the AHD more than once for this alarming increase, when actually the real cause for increases in schistosomiasis in urban Egypt is in migration, not the Aswan High Dam.

Whatever the exact figures, schistosomiasis is undoubtedly a tremendous health burden for the Egyptian rural population. The numerous age-prevalence curves cited here indicate that many persons who are not currently shedding ova have been previously and may develop chronic manifestations. Thus, trends based on ova detection in excreta do not render an exact figure for the total number actually infected but result rather in an underestimate. Nor is it known how many new urbanites are infected. Trends of this type only suggest relative changes in the number infected, and, in the case of rural Egypt, they do indicate a decrease. These points are important in view of the speculation concerning the impact of the AHD on the transmission of schistosomiasis. The question of the future impact of the Aswan High Dam on changing the transmission of schistosomiasis still remains. It is too early to know what changes will occur in reclaimed lands or in the new lake. The exact distribution of S. mansoni infections also remains to be resolved. Additional data are clearly needed. A review of trends presented in this study does show that all current results must be viewed against the historical context in which schistosomiasis has existed in Egypt for centuries.

The Nubian Study

Prevalence data for schistosomiasis were collected also in New Nubia. The objective was to determine if changes had occurred in the Nubian population after relocation. Previous to the filling of Lake Nasser and the inundation of the Nubian homes these people were living in an area over 450 kilometers long. Table 39 gives an indication of what some of the environmental conditions were in respect to housing and water supply. The majority obtained their water from the Nile, even when the Kanoose tribe was included in the total. Abdady and Shalash (1966) noted that many of the pumps in the Fadiga area were broken which means that many more families were taking their water from the Nile than indicated. After resettlement the Nubian water supply was improved, as has been pointed out.

This is one possible reason why prevalence of schistosomiasis has decreased in this population. The results from this study conclusively show that prevalence has dropped in the Nubian population. Zawahry (1964) found 12 years previous, in the same villages (not including Kalabsha (9) and Tushka (6)), that the overall prevalence was 15.2%. The adjusted prevalence from their study (including Kalabsha (9) and Tushka (6)) was 7.2%. If Kalabsha (9) and Tushka (6) were not included in the overall prevalence figures the improvement would be even greater. This is because Kalabsha (9) had an unusually high prevalence. A comparison between Zawahry's (1964) results and this study by village (compare Table 51 with Table 16) shows in every case that prevalence has dropped in the sites surveyed by Zawahry (1964). The most dramatic changes are seen in Ballana (5) and El Malki (9).

Aside from the improvement in water supply, a more important parameter contributing to the fall in prevalence is the change in irrigation practices following relocation. The Nubians had begun irrigation development in the 1950's in selected areas. Little development had occurred in the northern tribes because the low lands in their area had been inundated by the rising waters trapped by the first Aswan dam built in 1910. Most of the members of this tribe have had to relocate twice this century, the first time to higher rocky and very hilly ground, but within the same general region, the second time to New Nubia. The hilly areas of the first relocation were unadaptable to irrigation schemes, and thus Zawahry (1964) found a low prevalence of schistosomiasis. Since the Nubians have moved to Kom Ombo, their exposure to irrigation systems has lessened. One reason in addition to improved water supply is that the new villages were constructed strategically at a distance from the canals in the Kom Ombo plain. Water from the standpipes is far more convenient than that from the canals. Perhaps even more importantly, the Nubians were compensated by the government with land in the Kom Ombo. As land owners, the Nubians can and do hire locals to till and tend the fields. One last additional aspect that may also have contributed to controlling prevalence in the resettled Nubians is that schools, clubs, social centers, electricity, and rural health units and centers were all built into the resettled sites.

The findings at Kalabsha (9) remain an enigma. The unusually high prevalence of infection is unique to Nubia. The distribution of the infection between the sexes has not been seen in any of the other samples in this study or, for that matter, in any other study.

In the general survey of Nubia, there were no outstanding environmental or demographic features in the Kalabsha (9) study site that would provide an immediate answer as to why Kalabsha (9) had a much higher prevalence of schistosomiasis than any of the other villages sampled in Nubia. The age structure was not unique. The age-specific prevalence of Kalabsha (9) was proportionally higher in the middle age groups when compared to the results from the other Nubian sites, which typically fell in prevalence following the late adolescent and early adult age groups. It is possible that older Nubians who had previously been employed in the Nile Delta (or in other northern sectors of Egypt) were returning and brought with them infection acquired outside of Nubia. The observation that the male:female ratio has increased since resettlement indicates that many males have returned after resettlement. Fahim (1974) also noted that many of the Nubians who had migrated to the north for work were returning to join relatives who were now more accessible. This explanation seems unlikely, however. If it were true that returning Nubians brought schistosome infections with them, one would expect to see a similar elevation of prevalence in the other Nubian villages sampled. The general low prevalence detected in Nubia does not support this explanation.

Zawahry's (1964) results indicated that the tribe to which the Nubians of Kalabsha (9) belonged had had a low prevalence of schistosomiasis (4.1%). However, Zawahry also noted ten years previously, in 1954, that El Dakka, a nearby village belonging to the same tribe, had a perennial irrigation project, and had a high prevalence of schistosomiasis. Even if it could be shown that Kalabsha (9) had had an elevated prevalence before being moved and had simply carried the infection over to the new site, it would not explain how the prevalence has been maintained for twelve years in an area of predominately low prevalence.

Water and wastewater practices in Kalabsha (9) did not differ significantly from the other Nubian villages, all of which were provided by the government resettlement program and are very similar. Actually, more homes in Kalabsha (9) had electricity (57.4%) and cooked with karseen (94%) than in any of the other villages, indicating a superior economic status. Usually economic status correlates inversely with prevalence (Farooq, et al., 1966).

It is not known whether or not the people of Kalabsha (9) cultivate their own land or hire local saidies (Upper Egyptians) as the Nubians generally do (Fahim, 1974). If they do attend their own fields, the risk of exposure is probably much greater. This is an important parameter for follow-up studies, which are needed before an accurate evaluation of this anomaly can be established.

Finally, the results from Kazan Sharq (1) in Aswan must be considered. This village is populated by Nubians of the Kanoose tribe. Because it is located just north of the old Aswan Dam it represents a Nubian village which did not have to be relocated, either in 1910 when the old Aswan was built, or later when the AHD was erected.

As shown in Table 35, the prevalence of schistosomiasis in this village is 6.9%, typically low for a village with no irrigation schemes and only the Nile as a water source. There were no other environmental or demographic parameters in Kazan Sharq (1) which seemed out of place to what might have been expected if this village was studied 12 years previously when Zawahry (1964) completed the study on the Nubians before they were relocated. Indeed, there is no reason to believe that this village is not representative of conditions in Upper Egypt when basin irrigation existed throughout, or even of earlier periods. The results from Kazan Sharq (1) could easily be considered as an ultimate baseline for schistosomiasis prevalence in Nubia, Upper Egypt, or Egypt as a whole before development of modern agricultural techniques. The implication is that the Nubians in their original state, before there was any irrigation development by the southern two tribes very probably had a low prevalence similar to that in Kazan Sharq (1). During the 1950's, limited irrigation development resulted in sharp increases in the regions where these schemes were installed. Now, following relocation, the Nubians are, for the reasons stated above, isolated from sites where there is optimal transmission, (with the apparent exception of Kalabsha (9)) and, as a population over the past 12 years have been losing their infections. Part of this loss results from the dilution of an infected population with successive cohorts that remain free of infections. This would explain why the age prevalence curve for Nubia is not as marked in the younger age groups as would be expected under more stabilized conditions. Also, loss of infection could be occurring spontaneously and as a result of specific therapeutic treatment. Spontaneous loss probably does not account for a significant proportion, especially in the adult age groups, but little is known about this aspect of the disease. Loss of infection due to treatment may also be limited. Specific treatment has never been popular because of various reactions to the therapeutic agents available. The observation is that over a period of 12 years prevalence in the southern two tribes has dropped from 23% to less than 5%. It would seem in a period of 12 years, or perhaps less, a population no longer exposed is capable of shedding a substantial proportion of its infection. Whereas there have been many observations to show how quickly prevalence in a susceptible population can rise from a very low point to where virtually the entire population is infected (the results in Table 1 are an example) there is little or no data to show how quickly a population will cure itself. It is possible that the observations made in the southern two tribes, represented by El Malki (7) and Ballana (6), are an indication of this. It would be interesting to know what the real loss rates were. Predictions of decreases in prevalence following environmental control measures are badly needed, and, without this measure, it will be difficult to evaluate such projects.

The second hypothesis of this study is also rejected. The overall prevalence in the resettled Nubian population, Kalabsha (9) included, has decreased. An overall prevalence greater than 15% would be necessary before an increase could be considered. The estimated overall prevalence was only 8.8%.

The decline in schistosomiasis described here is encouraging. However, there is no evidence that indicates a continued decline in the prevalence. Changes are likely to occur and must be followed. The infection with schistosomiasis in over 6.9 million Egyptians estimated by this study demands continued concern.

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APPENDIX I

Resource Centers in Egypt

This is a list of centers in Egypt where material on aspects of schistosomiasis and other tropical infections may be found.

American University in Cairo, Library; Kasar El Aini Street, Cairo

The Egyptian Ministry of Health, Library; Garden City, Magles El Shob Street, Cairo

The High Institute of Public Health, Library; 165 El Horreya Street, Alexandria

Naval American Research Unit-3; c/o U. S. Embassy, Garden City, Cairo

American Cultural Library; Garden City, Cairo

Cairo University Medical Library; Giza, Cairo

British Cultural Library; Dokki, Cairo

World Health Organization, Library; Regional Office, Alexandria

APPENDIX II

DATA FORMS

CLINICAL EXAMINATION FORM 01

Code: Village ID ...... Family Id ...... Date ......

Name and ID code ....

Relation to head of household
Sex
Date of Birth
Age
Number of Years in Village
Marital Status
Number of Pregnancies
Number of Live Births
Number of Still Births

Most Recent Medications/Date:

First Diagnosis
Second Diagnosis

Urine Specimen
- S. haematobium
- S. mansoni

Height (cm)
Weight (kg)

comments

Education
- Preschool Age
- School Age Not Attending
- Does Not Read or Write
- Reads Only
- Reads and Writes
- Has Completed Primary School
- Has Completed Secondary School
- Has Received Higher Education
- No Information

Occupation
- None
- Landowner (Non-Farmer)
- Farmer
- Farm Laborer
- Fisherman
- Boatman
- Domestic Servant
- Skilled Laborer
- Other Manual Laborer
- Clerical
- Professional
- Housewife
- Tourist Guide
- Other

HOUSING FORM 02

Date
Village
Name of Owner
Address
Year House was Built

1. Construction material

stone or red brick	1
mud brick	2
wood or reed	3

2. Structure attachment

detached	1
one side only	2
two sides	3
three sides	4

3. Painted walls

exterior	1
interior	2

4. Yards

present	1
not present	2

5. Staircase

fixed	1
mobile	2
none	3

6. Roof material

concrete	1
wood	2

reed	3
mud	4

7. Roof condition

permeable	1
not permeable	2

8. Storage place for fuel materials

roof	1
stable	2
storage room	3
yard	4
none present	5

9. Floor construction

earth	1
concrete	2
tile	3
wood	4

10. Number of windows ....

11. Lighting

electricity	1
kerosene	2
other	3

12. Television

present	1
absent	2

13. Number of rooms ......

14. Number of persons living in house ....

15. Stable

inside	1
outside	2
none	3

16. Waste container

yes	1
no	2

17. Animal waste material

stable	1	canal	4
yard	2	roof	5
street	3	none	6

18. Cooking fuel

gas	1
oil	2

wood	3
dung	4

19. Stable cleaning

daily	1
weekly	2
monthly	3
never	4

Form continued on next page

20. Housing approach

non-earth:	
clean	1
littered	2
dry	3
wet	4
earth:	
clean	5
littered	6
dry	7
wet	8

21. Screens

yes	1
no	2

22. Mosquito nets

yes	1
no	2

23. Ownership

own	1
rent	2

24. Walls decorated

inside	1
outside	2
none	3

25. Water source

public	1
private	2
surface	3
ground, well	4

26. Water supply	drinking	bathing	laundry	utensils	animals
piped inside					
piped outside					
hand pump inside					

	hand pump outside	
	canal	
	drain	
	lake or pond	
	River Nile	
27.	Storage of water	
	metal	1
	ceramic	2
	earthenware	3
	other	4
28.	Wastewater drainage	
	concrete	1
	pipe	2
	brick	3
	tile	4
	earth	5
	other	6
29.	Latrine	
	yes	1
	no	2
30.	Is the latrine used?	
	yes	1
	no	2
31.	Is there a cover for the latrine?	
	yes	1
	no	2
	Date of latrine installation.......	
32.	Type of latrine	
	borehole	1
	pit	2
	masonry walls	3
40.	Water carriage present in the latrine?	
	yes	1
	no	2
34.	Septic tank present?	
	yes	1
	no	2
35.	Cesspool present?	
	yes	1

	no	2
36.	Location of latrine	
	inside	1
	outside	2
	stable	3

WELL FORM 03

Location Information:

Village ID Number
Date
Well ID Number

Type of well

Depth of water level

Diameter

Number of months a year dry

Date of installation

State of repair

Nearest latrine or wastewater disposal in meters

Approximate number of users per day

Drainage

- concrete
- brick
- tile
- earth

Use

- drinking water
- drinking and washing
- washing only
- not used

Contamination of well water with drainage possible?

CANAL FORM 04

Location Information:

Village ID Number
Date
Canal ID Number

Date of construction

Length

Width

Depth

Approximate discharge m^3/day

Irrigation canal: number of feddans irrigated

Use:

- drinking water supply (public use)
- drinking water
- bathing
- laundry
- washing utensils
- washing animals
- swimming
- wastewater disposal
- sewage outfall present
- animal waste disposal

Septic

Canal lined with concrete or tile

MOSQUE FORM 06

Location Information:

Village ID Number
Date
Mosque ID Number
Mosque Name

Date of construction

Construction material

- stone or red brick
- mud brick
- wood or reed

Interior yard and floor construction

- stone or tile
- reed
- earth
- concrete
- wood

Electricity

Water supply

- public (piped)
- private: surface ground

Drainage of wastewater

- concrete
- piped
- brick or tile
- earth
- other

Drinking water

- piped
- stored
  - metal container
  - ceramic container
  - other

Latrine

- present
- cover
- date of installation
- type

VILLAGE FORM 07

Location Information:

Village ID Number

Village Name

Governorate

Area

Latitude

Longitude

1. Population 1976

2. Total number of houses 1976

3. Street sanitation

   Always free of solid waste and litter
   Has regular collection of solid waste
   Paved (% coverage)
   Large collections of solid waste present
   Wastewater and/or mud present

4. Public lighting

   Electric
   Oil
   None

5. Solid waste collection service available for homes?

6. Public treated water supply yes no

   ground water surface water
   demand
   number of water points--outside in home
   number of taps working
   chlorination yes no

7. Ground water levels

8. Public wells Private wells

9. Climate

10. Terrain--elevation from sea level, etc.

11. Agricultural practices and general economy

WATER POINT FORM 09

Location Information:

Village ID Number
Date
Water Point ID Number

Number of taps

Number of taps working

Date of installation

Source of water

- well
- treated
- other

Drainage area

- concrete
- brick
- earth

Number of hours/day with flow

Approximate number of users per day

Use

- drinking
- drinking and washing
- washing only
- cooking
- not used

LAKE AND POND FORM 10

Location Information:

Village ID Number
Date
Lake or Pond ID Number

Size

- length
- width
- depth

Seasonal water levels

- winter
- spring
- summer
- fall

Use

- drinking water
- bathing water
- laundry
- washing utensils
- washing animals
- swimming
- wastewater disposal
- sewage or latrines
- solid waste disposal
- animal waste disposal

Number of drain outfalls present

Septic

WATER TREATMENT PLANT FORM 11

Location Information:

Village
Date
Village ID Number

1. Location of plant

2. Date when plant first began to operate
   How long has the plant been operating?

3. Population serviced:

   a. Does the plant serve the entire village?
   b. Does the plant serve less than the entire village? If so, how much is covered?
   c. Does the plant serve other villages or places besides the village? industrial sites?

4. Give location of the source of water used by the plant for treatment

5. Obtain the volume of water treated by the plant:
   daily

   yearly

6. Describe each point where chlorination of water is carried out currently in the treatment process.

   How much chlorine is being used?

7. Are there laboratory facilities to check the quality of the treated water? untreated? describe...

8. On the average how many hours each day does the distribution system have pressure?

9. Is there a water storage tower present? capacity?

APPENDIX III

CODE KEY AND CODING FORMS

CLINICAL CODE KEY

1. Clinical data code form number = 01

2. Code number of unit 01 to 20

01	Kazan Sharq
02	Guzaira
03	Abu Rish bahri
04	Ga'afra
05	Ballana
06	Tushka
07	El Malki
08	Kurta
09	Kalabsha
10	Bimban
11	Barout
12	Sherif Pasha
13	Naiim
14	Beni Adi
15	Ashmant
16	El Agazein
17	El Hamra
18	Mahalet El Kasab
19	Mahalet Mousa
20	Sheno

3. Family code number from 0001

4. Code number of person within the family from 01

5. Question 1: Relation to the head of the family
    1. Head of Family
    2. Wife
    3. Male offspring
    4. Female offspring

6. Question 2: Sex of the person or individual
    1. Male
    2. Female

7. Question 3: Date of birth. Use only the last two digits of the year of birth.
1943----43

99 = no information

8. Question 4: Age of the person or individual
Code for age groups
00 - 01
01 - 02
05 - 03
10 - 04
15 - 05
20 - 06
25 - 07
30 - 08
35 - 09
40 - 10
45 - 11
50 - 12
55 - 13
60 - 14
65 - 15

Example:
recorded on data form as age group 25-30
group code number = 07

9. Question 5: Number of years that individual has lived in this village. Recorded directly as number of years.

10. Question 6: Marital status of individual

1 Single
2 Married
3 Divorced
4 Widowed

11. Question 7: Number of pregnancies 99 means no information
0 means none

12. Question 8: Number of live births 99 means no information
0 means none

13. Question 9: Number of still births 99 means no information
0 means none

14. Question 10: Drugs taken for treatment of parasitic infection.

Blank on data form means no information = 99
Drugs or medication given for other infections means other =37
No medication or drugs received means none = 0
(This may be recorded on the data form as a slash)

First two boxes are for month of year when drug was given
Third box is for the year 1975 = 5

15. Question 11: Diagnosis of individual

A special code list is to be prepared

16. Question 12: Same as question 11.

17. Question 13: Examination for *S. haematobium* infection

Positive = 1
Negative = 2
No specimen

18. Question 14: Examination for *S. mansoni* infection

Positive = 1
Negative = 2
No specimen = 3

19. Question 15: Deleted

20. Question 16: Deleted

21. Question 17: Height of individual. Record directly as height.
Last column for fraction

22. Question 18: Weight of individual

56 kilograms; record as 0560
56.5 kilograms; record as 0565

23. Question 19:

The individual has not attended the examination =no response = 1
The individual is no longer living in the village = 2
The individual has died = 3
Form is blank for question 19 = 99
Stool specimen given = 4

24. Education of the individual

Record the number given
If question is blank = 99

25. Question 21: Swimming and bathing habits of the

individual
Record directly the number or numbers given
Example: 4 is recorded as 0004
1 and 4 is recorded as 0014, etc.
Use combinations.

26. Question 22: Occupation of the individual

Record directly the number given in the same fashion as in question 20. If the question is blank = 99 Note: Additional occupations not listed on the data form may be written in the space for the code number. In this case the occupation should be listed in the code guide and given a code number and recorded in the same fashion as above.

APPENDIX IV

Methods Guide for Field Survey

Standard Methods for Survey

Protocol for Selection of Sample Population

1. A family is a man and his wife(s) and all unmarried children. Single adults (if selected) who have no parents constitute a family. If a single adult living away from his parent(s) is selected, the parent(s) must also be located (only if living in the same village), as well as all other unmarried children.

2. It is not desirable to examine persons not selected from the sample frame. HOWEVER: older persons, village leaders and well known respected persons that desire to be included should be INVITED to the exam. Do not give a family code number to these families or persons.

3. If a selected family member is missing but will return to the village before the end of the survey, complete the exam for all other family members, but hold clinical form until the missing family member returns and then complete the form by examining the remaining member.

4. As families are selected from the sample frame they are simultaneously assigned a serial number starting with 0 0 1.

5. This serial number automatically becomes the family's ID code number and the ID code number for the family's house.

6. After each family is examined, their name is checked off the sample frame.

Clinical Exam Routine Outline

1. Before a selected family comes to the health unit (or center) a visit must be made to the home of the family by the health team engineer-sanitarian in order to:

   a) Inform the family about the clinical exam and that all members of the family should attend regardless of age or disability. (For those too disabled to leave the home the team from the unit must visit the home, carry out the clinical exam, and collect urine and stool samples)

   b) To inform the family that urine and stool specimens will be necessary at the health center.

   c) To complete the housing data form.

2. The first step once the family arrives at the health unit or center is for the doctor to enter the family ID code number on the clinical exam form 01 and the individual code numbers. The individual code number is at the left hand margin where the individual's name has been entered on the data form. Each individual then will have a 7 digit code number comprised of the two code numbers for the village, three for the family, and the last two for the individual.

CAUTION: Always take great care to avoid confusing individual ID numbers.

3. The nurse, assistant, or physician completes the data form which is non-medical, i.e. occupation, education, age, etc.

4. Urine specimens must be taken from each family member. The laboratory technician makes sure the specimen is given and placed in the correctly labelled container. The results of the examination of the urine are entered onto the data form.

5. Stool specimens must be taken from each family member (only a small volume is necessary). The laboratory technician copies the individual ID code number from the person giving the specimen on to a plastic stool specimen vial. The stool specimen is transferred without delay to the correctly labelled specimen vial according to protocol.

6. The weight and height of each family member is taken according to the protocol given and recorded in the appropriate place on the clinical exam data form 01.

7. A physical exam of each family member is made by the physician. A first and second diagnosis is made and this information is entered into the appropriate spaces on the data form.

8. The medication that may have been received previously is a very important aspect. This will require that the physician cross-examine the person until it is determined what, if any, medications have been taken. Only medications for parasitic diseases are of interest.

9. Please note that blood films will not be taken.

10. Check off the family name from the sample frame. This will prevent seeing the same family twice and will help show how many families have been examined.

11. Following the completion of the above activities the examination of the family ends. Go to the next family on the sample frame.

TECHNIQUE FOR PLACING THE PERSON IN THE CORRECT AGE GROUP

DC NOT ATTEMPT TO ESTIMATE EXACT AGE

00-01
01-05
05-10
10-15
15-20
20-25
25-30
30-35
35-40
40-45
45-50
50-55
55-60
60-65
65 +

Note: This guide is to be used when the person to be examined has no record of birth date or government-issued identification card.

METHOD FOR COMPLETING THE DATA FORMS

CLINICAL EXAM FORM 01

Enter village ID code number in box given and fill in village name.

Enter the family ID code number in the box given. This number has be the same as the house ID code number where the family lives.

> NOTE: One form is to be completed for each family, even if the family is only a single person. A family is a man and his wife(s) and all unmarried children. Single adults (if selected) who have no parents constitute a family. If a single adult living away from his parent is selected, the parents must also be located (only if living in the same village), as well as all other unmarried children. The entire family is then examined and all results are entered on the same clinical exam form 01.

Enter data in box given: day month year.

The name of each family individual is entered on the clinical exam form 01. Each member of the family then receives a tag with the village ID, family ID, and individual ID code number written (in this order) on the tag. The individual's ID code number is taken from the left hand margin of the clinical exam form where the individual's name has been entered.

There is no given order in which to complete the form. This is left to the team to manage and to suit the organization at the health unit or health center.

The following is a guide to each entry:

1) Relation to head: Write in the appropriate space the relation to the head of the family for each member.

2) Sex: enter male or female in the given space

3) Enter date of birth by year only. This is to be confirmed by checking the government-issued ID card.

4) Enter the age given by the individual. Do not

compute age.

5) Enter in the correct space the approximate number of years the individual has been living in the village. Confirm by checking on the location where the individual was born.

6) Marital status: enter in the correct space single, married, divorce, or widowed.

7) Enter in the correct space the number of pregnancies. If male or unmarried enter 0.

8) same as above.

9) same as above.

10) Medication received: This cannot be left blank. Each person must be thoroughly checked. If there has not been any medication received enter NONE in the correct space. If medication was received for illness other than parasitic infections enter OTHER. If medications have been received for any parasitic disease, especially for bilharzia, enter name of drug received, and give month and year.

11) Enter the first and second diagnosis in the correct spaces.

12) Same as above.

13) Urine: If the results from the urine examination are negative for S. haematobium enter a 0 in the given space. If positive, enter a 1. Do the same for S. mansoni. NOTE: all ova must be positively identified as either S. haematobium or S. mansoni.

14) Same as above.

15) Blood films: Originally, blood films were to be made.

16) Same as above.

17) Height and Weight: enter each measurement in the given space. Refer to standard methods guide for the measurement of height and weight to make sure that the data is obtained according to the desired technique.

18) Same as above.

19) Comments: This has been provided for the physician in charge.

20) Education: Enter a 1 for each positive answer. Make sure that score is placed in the correct row and column.

21) Swimming: ASK "Where do you swim or bathe?". After entering the answer in the correct given space ASK "Where else do you swim or bathe?". Continue asking this question until the person states that there are no other places where he or she swims or bathes.

22) Occupation: After inquiry, enter 1 under the correct occupation in the space given. Make sure that the score is placed in the correct row and column.

23) Stool specimen: Enter a 1 if stool specimen has been given. Always double check to see if the individual has given the specimen.

Urine Examination Protocol

1. The entire voided urine is collected in a conical flask. The flask is numbered with the individual's ID code number.

2. The urine is allowed to settle without disturbance for 30minutes.

3. A clean pipette is used to collect the sediment and a drop of the sediment is placed on a clean glass slide. Two more drops are placed into an empty but coded specimen bottle.

4. The slide is examined under the microscope for schistosome eggs.

5. A specimen is not negative until all the sediment has been examined.

6. ALL OVAL MUST BE POSITIVELY IDENTIFIED AS EITHER S. HAEMATOBIUM OR S. MANSONI.

PROTOCOL FOR HANDLING STOOL SPECIMENS

1. The stool specimen is received. The ID number of the individual giving the specimen is immediately copied onto a bottle with a felt-tip pen.

2. Stool is placed into the plastic stool specimen bottle in the following manner without delay.

a) Open the bottle and remove the inner plastic cap. Add a few drops of MIF.

b) With a small wooden palm stick place very small pieces of stool in the bottle on the bottom. Each piece should be selected from a different area of the stool specimen.

c) About one c.c. of stool should be transferred to the bottle. This may require 8 to 10 pieces and should be about the same amount as a "foul" bean.

d) Add a few more drops of MIF solution and mix the specimen until all the stool has been completely broken up.

NOTE: Two drops or .1 ml of urine sediment from the urine specimen should also be added to the correct corresponding stool specimen bottle.

e) Add MIF solution until the bottle is almost full. Leave the neck of the bottle empty.

f) Place the white plastic inner cap inside the black outer cap and then place both over the top.

g) Carefully rock the inner cap into place with the black cap. Then remove the black cap and make sure the inner cap is firmly in place. Pressure can be applied with the black cap if the inner cap is still not in the desired position.

h) Recheck and make sure that the label is the correct label. The bottle is now ready to be transported.

TECHNIQUE FOR THE MEASUREMENT OF HEIGHT AND WEIGHT

1) All selected family members are to be weighed and measured for height regardless of age or disability.

2) Procedure for the determination of weight.

   a) each member is weighed with a minimum amount of clothes and without shoes. (NOTE: regardless of how much clothes are worn during weighing make sure that all wear the same amount of clothes during weighing. Do not allow one person to be weighed fully clothed and then weigh the next half clothed.

   b) Infants that cannot stand unsupported are to be weighed with the mother after the mother's weight has been taken and recorded. (Infants should be clothed only in diapers) When an infant is weighed in this manner he total weight of the mother and child is recorded.

   c) Check each week that the scales are working correctly by weighing known standards.

3) Procedure for the determination of height.

Adults

   a) Place the tape in a convenient place on the wall. The person's heels, buttocks, shoulders, and back of head should touch the wall. The tape should be directly behind the head.

   b) Remove all head gear if it has not already been removed. This includes turbans, hats, scarves, etc.

   c) Place a right angle (book, etc) against the wall and press down to the top of the head. Contact has to be made with the top of the head.

   d) Record height to the nearest 0.5 cm.

Infants

a) All infants who cannot walk are to be measured lying down.

b) This will require two persons to take the measurement.

c) One person holds the head firmly against a 90° upright.

d) The other person straightens the body by holding the ankles together with one hand, while with the other hand the 90° sliding upright is placed firmly against the infant's feet.